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## Seasonal Round Travel Routes and the Cost of Mobility

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# SEASONAL ROUND TRAVEL ROUTES AND THE COST OF MOBILITY

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A Thesis  
Presented to the  
Faculty of  
California State University,  
San Bernardino

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In Partial Fulfillment  
of the Requirements for the Degree  
Master of Arts  
in  
Applied Archaeology

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by  
Evan Alexander Mills

June 2018

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Evan Alexander Mills

June 2018

Approved by:

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Pete Robertshaw, Committee Member

Bill Sapp, Committee Member

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## ABSTRACT

In 1985 a settlement and subsistence model of seasonal round mobility was proposed by Statistical Research, Inc. This model proposed four travel routes used by the Late Prehistoric Serrano to access the higher elevation village site known as Rock Camp to gather acorns and pinyon nuts in the fall. This research investigates the proposed routes, as well as an additional route, for energy efficiency and archaeological evidence of use in prehistory. Data collection involved using experimental methods designed to gather controlled physiological data for evaluating the efficiency of traveling each route. Archaeological sites present on the travel routes and within the research area and were analyzed for elements indicative of prehistoric settlement characteristics. A combination of physiological evidence and archaeological evidence are the basis for determinations on which routes were most likely to have been used in prehistory. An analysis of the settlement model is also provided in order to provide future research with guidelines and context for evaluating sites within the region. Suggestions are provided for future studies to focus on chronology and expansion of the settlement model.

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## DEDICATION

To Mom and Pops.



## TABLE OF CONTENTS

ABSTRACT .....	iii
ACKNOWLEDGEMENTS .....	iv
LIST OF TABLES .....	ix
LIST OF FIGURES .....	x
CHAPTER ONE: INTRODUCTION .....	1
CHAPTER TWO: PROJECT BACKGROUND	
Natural Setting .....	6
Archaeological and Cultural Context .....	10
Chronology .....	10
Ethnographic Information .....	16
Previous Research in the Region .....	19
CHAPTER THREE: THEORETICAL FRAMEWORK AND RESEARCH DESIGN .....	30
Seasonal Round .....	33
Mobility .....	36
Research Design .....	40
Test Implications .....	43
CHAPTER FOUR: METHODS .....	45
Logistics .....	48
Controls .....	50
Equipment .....	52
Mapping .....	53
CHAPTER FIVE: RESULTS .....	55
Physiological Results .....	56
Archaeological Results .....	61

Route Specific Results .....	63
Pinnacles South .....	64
Upper Kinley .....	69
Lower Kinley .....	71
Burnt Flats West .....	75
Grass Valley Creek .....	81
Pacific Crest Trail/Deep Creek .....	84
Exploratory .....	88
CHAPTER SIX: DISCUSSION AND CONCLUSIONS	
Energetic Considerations .....	91
Conclusions .....	97
Settlement Model and Analysis .....	99
Directions for Future Research .....	104
REFERENCES CITED .....	108

## LIST OF TABLES

Table 1. Chronological framework from <i>Sutton et al. 2007:236</i> .....	12
Table 2. Physiological results on investigations gaining in elevation. ....	57
Table 3. Physiological results of investigation losing elevation.....	58
Table 4. New archaeological sites.....	61
Table 5. Site types present along the Pinnacles South route. ....	69
Table 6. Sites located along Upper and Lower Kinley. ....	74
Table 7. Sites along Burnt Flats West route. ....	80
Table 8. Settlement sites along Pacific Crest Trail/Deep Creek. ....	87

## LIST OF FIGURES

Figure 1. San Bernardino Mountains .....	2
Figure 2. Mojave Forks region .....	3
Figure 3. Research area.....	6
Figure 4. Illustration from Smith and Moseley 1962: 20.....	23
Figure 5. Model of proposed travel routes (Altschul <i>et al.</i> 1985: 72).....	27
Figure 6. Google Earth rendition of the Altschul <i>et al.</i> model.....	28
Figure 7. Map of proposed routes and additional Pacific Crest Trail/Deep Creek route. ....	47
Figure 8. Pinnacles South investigation. Upper and Lower sections. ....	67
Figure 9. Pinnacles South investigation. 650m gap of uncompleted survey. ....	68
Figure 10. Upper Kinley investigation. ....	71
Figure 11. Lower Kinley investigation. ....	73
Figure 12. Settlement sites along Kinley Creek. ....	75
Figure 13. Burnt Flats West investigation. ....	77
Figure 14. Navigational error resulting in increased calorie expenditure on Burnt Flats West.....	78
Figure 15. Second navigational error resulting in increased calorie expenditure on Burnt Flats West. ....	79
Figure 16. Settlement sites along Burnt Flats West.....	81
Figure 17. Grass Valley Creek investigation.....	83
Figure 18. Pacific Crest Trail/Deep Creek investigation. ....	85

Figure 19. Settlement sites along Pacific Crest Trail/Deep Creek. ....	88
Figure 20. Exploratory investigation. ....	90
Figure 21. Burnt Flats paths of travel.....	94
Figure 22. Path of Highway 173. ....	96
Figure 23. Settlement sites and water drainages.....	103
Figure 24. Areas of potential settlements. ....	104

## CHAPTER ONE

### INTRODUCTION

The San Bernardino Mountains separate coastal southern California from the Mojave Desert (Figure 1). The range was and is home to a Native American people known as the Serrano. Researchers have suggested the Serrano practiced a seasonal round mobility pattern of settlement and subsistence consisting of winter villages at the base of the mountains and higher elevation spring, summer, and fall settlements at different elevations in the mountains during these warmer times of year (Altschul *et al.* 1985; Bean and Smith 1978; Benedict 1924; Strong 1929). This thesis investigates the use of travel routes from the lower elevation settlements to known settlements at higher elevations during the Late Prehistoric (cal A.D. 1100 – contact) in the Mojave Forks region of the range (Figure 2). I have had an interest in this region for many years as I grew up in the San Bernardino Mountains and spent my childhood roaming the woodlands north of the town of Lake Arrowhead. As an archaeologist I would like to contribute to the growing interest in research issues related to the prehistory of the San Bernardino Mountains.



Figure 1. San Bernardino Mountains.

In 1985 at the request of the United States Army Corp of Engineers, Statistical Research Inc. (SRI) investigated the area known as the Mojave Forks Region. The Mojave Forks Region is located at the base of the northern side of the range where multiple tributaries of the Mojave River system converge before debouching into the Mojave Desert to the north. This 1985 report presented a settlement and subsistence model of seasonal round mobility, proposing various travel routes likely used by the Late Prehistoric Serrano to access the high elevation settlement known as Rock Camp (CA-SBR-342). Rock Camp is a large

prehistoric settlement located north of the current town of Lake Arrowhead and is assumed to be one of the primary high elevation settlements in the region due to its size (~325 meters [m] x 150 m) and location (currently at the transition between chaparral and mixed conifer and oak woodlands). Due to its assumed primacy in the settlement round, SRI modelled all routes on the range leading to and from Rock Camp. This model of settlement and mobility was based on locations of known archaeological sites, seasonality of available resources, and ethnographic information specific to this part of the mountain range.

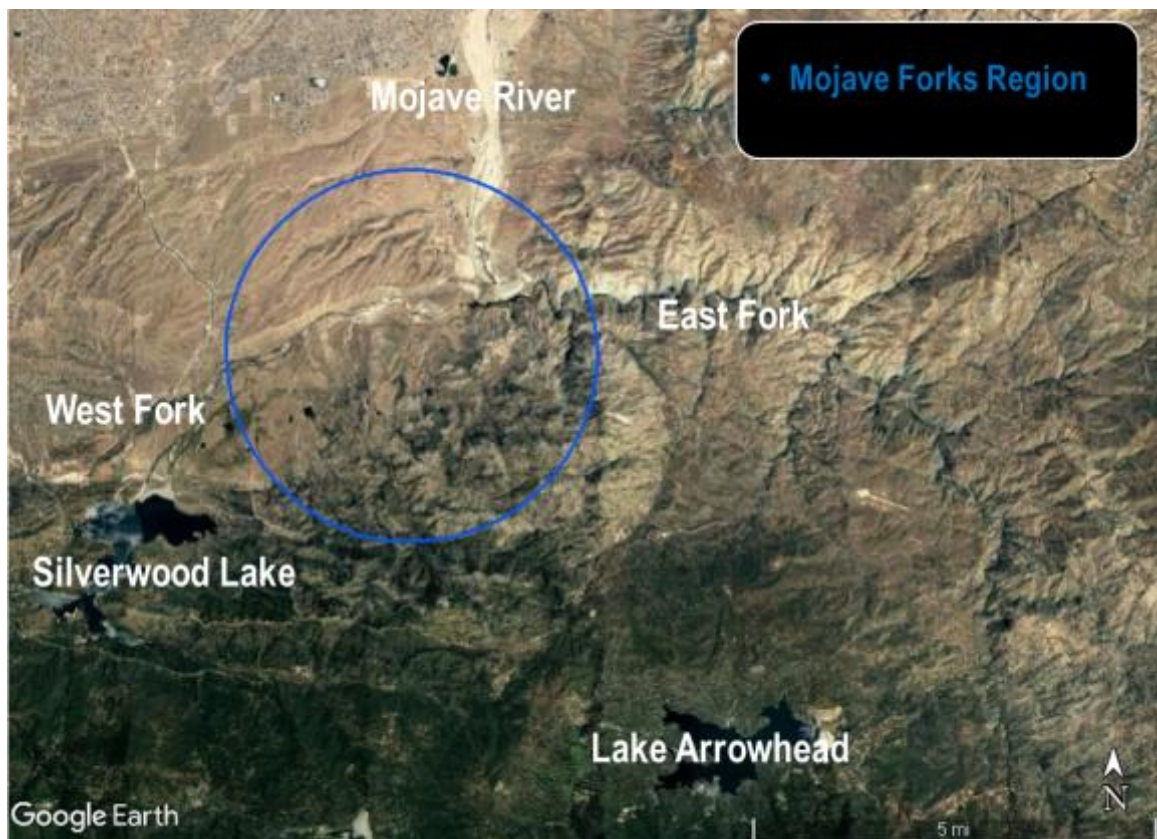


Figure 2. Mojave Forks region.



The objective of this thesis project is to test the model proposed by SRI using experimental methods of mobility replication. All four routes proposed by SRI were investigated on foot by traveling the routes in both directions (ascending and descending in elevation). An additional route (not proposed by SRI) was investigated to provide additional data for comparisons with data gathered on the proposed routes. The primary data for evaluation are physiological: calories required, distances traveled, elevation gained and lost, pace of travel, heart rate (average and maximum), and time required to travel. A series of methodological controls were implemented in order to maintain consistency of physiological data for comparisons. Secondary data sources to evaluate the travel routes are the archaeological sites on or near to the proposed routes, as well as the route not included in the SRI model. Archaeological sites in the research area provide valuable information regarding the distribution of sites, prehistoric activity at the sites, and differentiation between site types related to settlement and subsistence practices.

The core theoretical principle for this research comes from Human Behavioral Ecology and Optimal Foraging Theory. Energy efficiency relies on maximizing energetic returns while minimizing energetic output. This thesis focuses on environmental factors that have an impact on energy expenditure to travel up and down the mountains. Efficient travel in the mountains combines factors of topography, density of vegetation, and distances to be traveled; all have an impact on energetic requirements. The physiological data gathered will

serve as the quantitative measures to evaluate the routes for efficiency. The archaeological data will serve as the correlation to either support or reject the results of the physiological data. An analysis of the previously recorded archaeological site constituents is conducted to differentiate site types. Using the physiological data and the archaeological data, the goal is to have a positive correlation between the energy efficiency of a route and the frequency of archaeological evidence to support the hypothesis of its use in prehistory as a travel route.

This thesis outlines the natural setting, cultural context, and previous research in the region. The main source of inspiration for this thesis is the Altschul *et al.* (1985) settlement and subsistence model for the San Bernardino Mountains in the Mojave Forks region. The theoretical stance chosen is the basis for the methodological choices. The results and discussion are intended to provide additional information by which the settlement and subsistence model may be refined and expanded.

## CHAPTER TWO

### PROJECT BACKGROUND

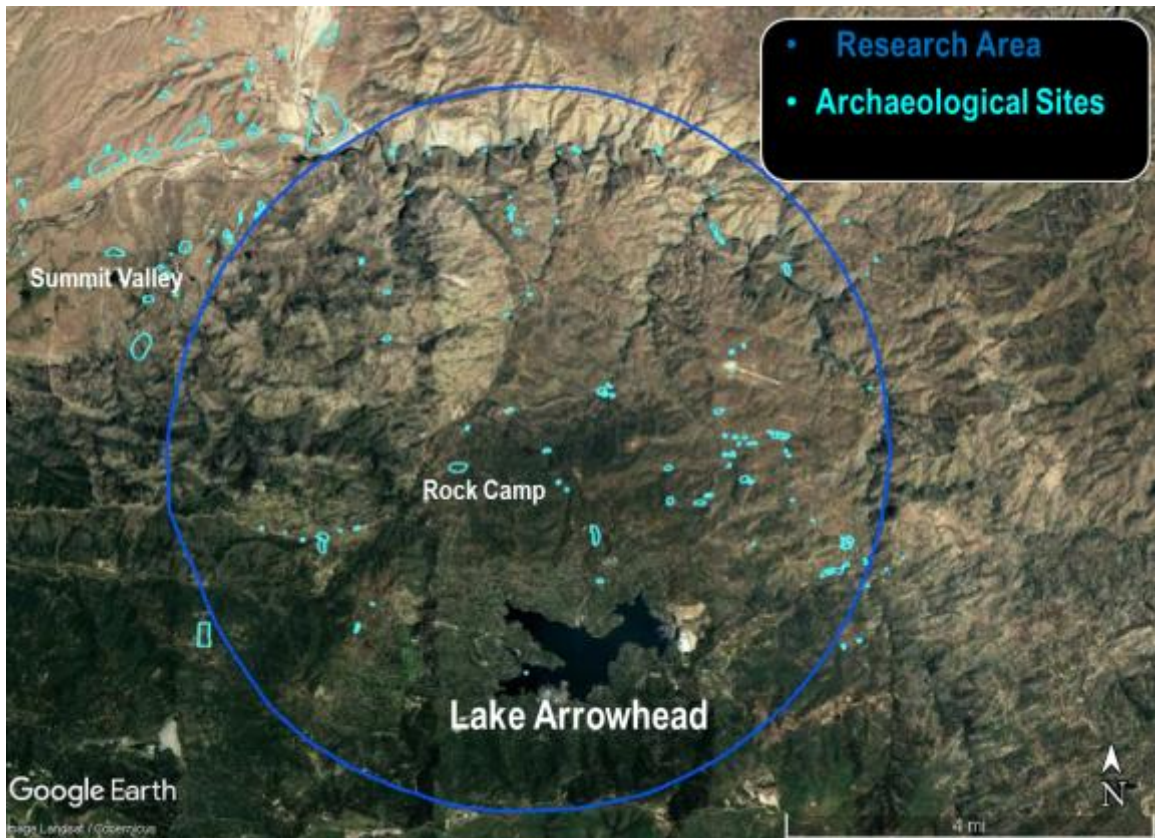


Figure 3. Research area.

#### Natural Setting

This research project was conducted in a small corner of the San Bernardino Mountains (Figure 3) located north of the town of Lake Arrowhead. The San Bernardino and Little San Bernardino Mountains make up the eastern extent of the Transverse Range in southern California. This range stretches approximately 60 miles from the Cajon Pass in the west to Morongo and Yucca

valleys in the east, dividing two different geographic regions in the southern portion of the state. The Mojave Desert and Great Basin are north of the range, while the interior regions of coastal southern California and the Colorado Desert are south and southeast divided by the Peninsular Ranges. Elevations range from 1100 feet to 11,489 feet at the peak of San Geronio Mountain.

The San Bernardino Mountains and southern California has a Mediterranean climate characterized by winter precipitation and summer drought (Minnich 2007: 43). The mountain climate has true seasonality in comparison to the surrounding regions. Temperature in the mountains can range from an average low of 29 degrees Fahrenheit in the winter months, to an average high of 81 degrees Fahrenheit in the summer months (usclimatedata.com). While surrounding areas have been increasing in annual mean temperature since the 1940s, the region of the range around Lake Arrowhead has remained relatively stable (Sawyer 2014: 4). The mountains experience an average annual rainfall of 41.66" (usclimatedata.com). Sediment cores taken from Lower Bear Lake (what is now Big Bear Lake) indicate that over the past 9170 calendar years before present (cal BP) there have been five major pluvial episodes (Kirby *et al.* 2012). These episodes occurred in the following time ranges; 9170-8000, 7000- 6400, 3350-3000, 850-700, and 500-476 cal BP (Kirby *et al.* 2012: 62).

The San Bernardino Mountains long axis is oriented west to east creating two major watersheds. The southern slopes drain into the Santa Ana River and flow to the Pacific Ocean. The northern slopes drain into the Mojave River

feeding the now dry lakes of the Mojave Desert. Deep Creek is the largest waterway that feeds into the Mojave River at its headwaters in Summit Valley and is the most reliable year-round water source in this portion of the mountain range. The headwaters of the Mojave River occupy an important position on a “major native travel corridor” (Earle 2005: 1) connecting the Pacific Coast to the Colorado River.

The San Bernardino Mountains are the result of tectonic interaction between the Pacific Plate and the North American Plate (Matti and Morton 2000: 8-9). The major fault causing the creation of the range is the San Andreas. The range began uplifting approximately two million years ago and continues uplifting today (Matti 2000: 9). The research area for the current project is located in a Mesozoic Quartz Monzonite geologic formation (Altschul *et al.* 1985: 5). The landscape of the research area is characterized primarily by decomposing granitic soil where quartz of varying quality exists in veins running through the bedrock and soils. The western portion of the research area known as the Pinnacles is a series of peaks and valleys covered in small to building sized granite boulders.

The vegetative ecosystems of the range consist of mixed conifer and oak woodlands, pinyon juniper woodlands, chaparral, and semi-desert areas (fs.usda.gov). The research area is comprised of mixed conifer and oak woodlands in the south (higher elevation) and chaparral on the slopes down to Summit Valley in the north. The drainage bottoms of the research area contain

riparian woodlands (Altschul *et al.* 1985: 9) consisting of fremont cottonwood (*Populus fremontii*), black cottonwood (*Populus trichocarpa*), California sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*).

The mixed conifer and oak woodland in the south of the research area is comprised of California black oak (*Quercus kelloggii*), canyon live oak (*Quercus chrysolepis*), and coulter pine (*Pinus coulteri*). This mixed conifer and oak woodland has an elevation range from 3500'-6500' (Altschul *et al.* 1985: 10). There are very few single leaf pinyon pine (*Pinus monophylla*) remaining in the research area.

The chaparral zone (elevation 2500'-6500') that makes up the majority of the research area (everywhere except riparian zone) is classified as chamise-manzanita type (Altschul *et al.* 1985: 10). chamise (*Adenostoma fasciculatum*) is the dominant plant and manzanita (*Arctostaphylos pringlei*) is more sparsely distributed across the slopes. Other common plants of the chaparral zone are yucca whipplei (*Hesperoyucca whipplei*), chia (*Salvia columbariae*), buckwheat (*Eriogonum fasciculatum*), rabbitbrush (*Ericameria nauseosa*), yerba santa (*Eriodictyon trichocalyx*), beavertail cactus (*Opuntia basilaris*, *chlorotica*, *englemannii*) and sage brush (*Artemisia tridentate*) (McKay 2005: 3).

The mammalian fauna of the area consists of mule deer (*Odocoileus hemlonus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), black bear (*Ursus americanus*) (grizzly bear in prehistory), western gray squirrel (*Sciurus griseus*), raccoon (*Procyon lotor*), mountain lion (*Puma concolor*), black-tailed jackrabbit

(*Lepus californicus*), chipmunks, mice, wood rats, and pocket gophers. Other species inhabiting the region are lizards, avian species such as ravens, acorn woodpecker (*Melanerpes formicivorus*), and turkey vultures (*Cathartes aura*) among others (McKay 2005: 3). The frequency of encounters with many of the above listed fauna is much higher in the upper elevation mixed conifer and oak woodlands compared to the chaparral slopes.

### Archaeological and Cultural Context

The archaeological and cultural context of the region is difficult to frame. There are several different means by which one can contextualize the prehistory of the region. Much of the archaeological research in the area was conducted in the 1960s and 1970s and the standards of today have improved substantially. In order to frame the prehistoric context of the region one must decide on a specific chronology borrowed from an adjacent region.

#### Chronology

There has been no formal breakdown of the prehistoric chronology for the San Bernardino Mountains. It is likely that humans entered the region during the Paleo-Indian period (10,000 B.C -8000 B.C.); however, currently there is no evidence of Paleo-Indian occupation in the mountains (McKay 2005: 4). Formal excavations have been limited in the range and the majority of chronological indicators for occupation are based on relative dating techniques using chronologically sensitive diagnostic artifact types (e. g. projectile points, shell

beads). The adjacent region of the Mojave Desert has been more reliably dated and will provide the chronological framework used for this research (Table 1).



Table 1. Chronological framework from *Sutton et al. 2007:236*.

<i>Temporal Period</i>	<i>Cultural Complex</i>	<i>Approximate Dating</i>	<i>Previously Known As</i>	<i>Marker Artifacts</i>
Pleistocene	Pre-Clovis (hypothetical)	Pre-10,000 cal B.C.	Early Man Early Humans Pre-Projectile Point	Unclear
	Paleo-Indian	10,000–8000 cal B.C.	Clovis Early Systems Big Game Hunting Tradition Malpais	Fluted points (Clovis)
Early Holocene	Lake Mojave	8000–6000 cal B.C.	Western Pluvial Lakes Tradition Western Lithic Co-tradition Western Stemmed Tradition Playa Complex San Dieguito Complex Lake Mohave Complex Early Archaic Death Valley I Period I	Stemmed points (e.g., Lake Mojave, Silver Lake)
	Pinto			
Middle Holocene		7000–3000 cal B.C.	Little Lake Amargosa I Period II Death Valley II	Pinto Series points
	Deadman Lake		N/A	Contracting stemmed and leaf-shaped points
Late Holocene	Gypsum	2000 cal B.C.–cal A.D. 200	Newberry Elko Amargosa II Period II Death Valley II	Gypsum and Elko Series points
	Rose Spring	cal A.D. 200–1100	Saratoga Springs I Period III, Phase II Late Rose Spring Haiwee Death Valley III Period III Saratoga Amargosa I Amargosa III	Rose Spring and Eastgate Series points
	Late Prehistoric	cal A.D. 1100–Contact	Yuman Hakataya Patayan Period IV Prehistoric Shoshonean Protohistoric Shoshonean Marana Cottonwood	Desert Series points, ceramics

The prehistoric chronology presented by Sutton *et al.* (2007: 233-243) will be the analogous framework used for this research. They present a temporal timeline including the Late Pleistocene (Pre-10,000 – 8000 cal B.C), Early Holocene (8000 - 6000 cal B.C), Middle Holocene (7000 – 3000 cal B.C) and Late Holocene (2000 – contact with Europeans in the 16th century) (Sutton *et al.* 2007: 236). Within this temporal timeline are cultural complexes provided to narrow the timeframes further, such as Paleo-Indian, Lake Mojave, Pinto, Gypsum, and Late Prehistoric.

The Late Pleistocene period is broken into two separate sub-periods: Pre-Clovis and Paleo-Indian. The Pre-Clovis period is “hypothetical” in this chronology due to the lack of reliable dates for cultural material attributed to this time period (Sutton *et al.* 2007: 236). The Paleo-Indian period is characterized by fluted projectile points that are indicative of the Clovis Complex. The frequency of Clovis sites is low and “Their archaeological signature is so faint as to be almost unrecognizable” (Fagan 2004: 53). Clovis points or Clovis “like” tools have been reported from various parts of the Mojave, such as China Lake, and Lake Manix (Moratto 2004: 77). The timing of this loosely defined period is subject to debate in the archaeological community (Erlandson *et al.* 2007; Moratto 2004: 37-70; Whitley and Dorn 1993).

The Early Holocene period is characterized by the Lake Mojave Complex and a small overlap into the Pinto Complex. The Lake Mojave Complex falls within the same time frame as the Western Pluvial Lakes Tradition and San

Dieguito Complexes. The archaeological assemblages of the Lake Mojave Complex are characterized by stemmed projectile points, flake knives, elongate keeled scrapers, and end and side scrapers (Moratto 2004: 95). While the previous time period is ill defined, the Lake Mojave Complex is touted as “the only truly coherent and integrated archaeological pattern in the region during this time” (Sutton *et al.* 2007: 234). The Lake Mojave Complex is associated with the many pluvial lakes of the interior Mojave where prehistoric peoples practiced a “forager-like” subsistence strategy based around these lacustrine environments (Sutton *et al.* 2007: 237; Moratto 2004: 96-97). Within the San Bernardino Mountains, Lake Mojave Complex artifacts are typically surficial finds (Denardo and Texier 2011: 83).

The Pinto Complex overlaps the Early Holocene and Middle Holocene periods, a time of transition to more arid conditions (Moratto 2004: 410). The Pinto Complex is marked by new styles of projectile points and, most importantly, the emergence of milling stone technology (Sutton *et al.* 2007: 238; Moratto 2004: 412; Warren 2002: 139). The Pinto Complex is aligned with the Altithermal, a period of warming between 9000 -5000 years BP that brought changing climate conditions, a transition from a cool wet climate to a dry and arid climate, causing many of the pluvial lakes to evaporate (Moratto 2004: 103; Moratto, King and Woolfenden, 1978: 148; Fagan 2004: 83). This climactic shift is proposed to be one of the reasons that human groups in the Mojave shifted from a forager to a collector strategy (Warren 2002: 138). The Pinto Complex is also represented in

the archaeological assemblage of the San Bernardino Mountains (Denardo and Texier 2011: 84). In the Mojave Desert, the transition between the Middle and Late Holocene is marked by the Deadman Lake Complex. This complex is ill defined but thought to be characterized by contracting stem (tapered base) and leaf shaped projectile points (Sutton *et al.* 2007: 236).

The Late Holocene is broken up into three separate periods, Gypsum, Rose Spring, and Late Prehistoric. The Gypsum Complex (2000 cal B.C. – cal A.D. 200) is characterized by small dart points such as Elko and Humboldt styles (Sutton *et al.* 2007: 241; Moratto 2004: 414). This Complex occurred during cooler wetter times in comparison to the Middle Holocene. Milling stones are frequent in Gypsum Complex assemblages, and this period is when the mortar and pestle first appeared in the regional archaeological record (Moratto 2004: 416). Many other types of non-utilitarian artifacts like pendants, stone and shell beads, and split twig figures become more frequent in archaeological assemblages (Moratto 2004: 418). The Rose Spring Complex (cal A.D. 200-1100) signifies the earliest appearance of bow and arrow technology characterized by Rosegate projectile points and pottery. This Complex is recognized as a time when major cultural systems shifted to larger populations, with more specialization noted in artifact assemblages (Sutton *et al.* 2007: 236-241; Moratto 2004: 420-424). The Late Prehistoric is characterized by more frequent occurrence of ceramics in assemblages, as well as Cottonwood and Desert Side Notch arrow points. All of these cultural complexes (Gypsum – Late

Prehistoric) are represented in archaeological assemblages found in the San Bernardino Mountains (Denardo and Texier 2011: 84-86).

### Ethnographic Information

There is a fair amount of ethnographic information about the inhabitants of the San Bernardino Mountains in the Late Prehistoric. The region was inhabited during Late Prehistoric by people known as the Serrano. In the early 19<sup>th</sup> century the name Serrano was given to the local inhabitants by the Spanish and means “mountaineer or highlander” (Bean and Smith 1978: 570). The linguistic dialect of the Serrano resides within the larger Uto-Aztecan language family (Benedict 1924: 366). The Serrano dialect is within the Takic branch of the Uto-Aztecan language family (Bean and Smith 1978: 570). The Serrano are related both linguistically and possibly ethnically with surrounding tribes such as the Cahuilla, Luiseño, Cupeño, Kitanemuk and Vanyume (Bean and Smith 1978: 570). The Serrano lived in and around the San Bernardino Mountains and were organized into two patrilineal, exogamous moieties known as Wildcat and Coyote. Within these moieties were several different patrilineal, patrilocal, exogamous clans that owned specific territory in the mountains (Bean and Smith 1978: 572; Strong 1929).

The settlement and subsistence pattern of the Serrano is not well defined in early ethnographic literature. In her article *A Brief Sketch of Serrano Culture* (1924), Ruth Benedict devotes the final five paragraphs to “Food”. She expresses the importance of pine nuts, acorns, and deer in the diet, how these items were

prepared, and customs associated with the consumption of the foods. In the *Handbook of North American Indians, Vol. 8* (Serrano section) Lowell Bean and Charles Smith (1978: 570) reiterate the importance of pine nuts and acorns in the diet, but also reference lesser known dietary staples like chia and mountain quail (*Oreortyz pictus*). Bean and Smith (1978) emphasize the importance of settlements or villages situated close to water sources, and they note the frequent occurrence of earth oven features, which are common on the western end of Summit Valley in the Crowder Canyon area (see also Basgall and True 1985). Considering that many dietary staples for the Serrano, such as pine nuts and acorns, occur naturally in the higher elevations of the mountains, travel to these areas would have been an important aspect of the Serrano mobility pattern. The trails that would have provided access to these higher elevations would also have been an important feature on the landscape (Northwest Economic Associates 2004: 43).

When considering staple foods that may influence movement of people in the San Bernardino Mountains, the nuts from the single leaf pinyon pine (*Pinus monophylla*) and acorns from California black oak (*Quercus kelloggii*) would have been among the most influential. Single leaf pinyon pine exists at elevations ranging from 3000 feet to 9000 feet (Altschul *et al.* 1985:11). This elevation range extends throughout the entire study area and the life cycle of when pinyon pine trees produce a harvestable crop may have been influential for population movement. Pinyon pines produce cones and seeds roughly every three seasons

(fs.fed.us; Lanner 1981: 208) and the large elevational distribution of the resource would require carefully planned seasonal rounds in order to be present at the stands producing cones and seeds in any given season.

California black oak exists in a more restricted elevational range of 3500 feet to 5000 feet (Altschul *et al.* 1985: 10) and is currently only in the southern, highest elevations of the research area. Mature trees produce acorns every two years (fs.fed.us). With a more consistent seasonal yield, the population movements dictated by California black oak may have been less complex than those to gather pine nuts.

While the ethnographic documentation focuses on the Serrano, there is a substantial amount of information regarding non-native use of the northern end of the project area in Summit Valley. The earliest known account of a European traveling through the region along the “Old Mojave Trail” took place in 1776 by Father Francisco Garces (Weaver 1982: 142). His expedition traveled from the interior of the Mojave along the river, through Summit Valley and over the mountains into the San Bernardino Valley. While not a focus for this research, the Las Flores Ranch mentioned in the historic account has been identified as occupying the same area as the Serrano Village of *Guapiabit* (Northwest Economic Associates 2004: 51; Weaver 1982: 143). The village of *Guapiabit* is also referenced extensively in *Fray Joaquín Pascual Nuez's Account of the Mojave River Expedition of 1819* (Earle and Nuez 2010) as a hub or resting area along the Old Mojave Trail. The entire area of Summit Valley and upper Mojave

River was a location of trade and economic activity in the 18th and 19th centuries. The villages of *Guapiabit* and *Atongaibit* (another site located along this route) were ideally located to facilitate the movement of mountain foods (acorns and pine nuts) downriver to the interior Mojave (Earle 2005: 10).

These ethnographies illustrate a connection to the resources located at higher elevations that were vital to the survival of the Serrano. Understanding how they exploited these foods is essential to understanding their relationship with the land. Knowing when and where to be on the landscape to have a successful harvest is the core principal of an optimal seasonal round mobility pattern (see Chapter 3).

#### Previous Research in the Region

Archaeological research has been undertaken in the San Bernardino Mountains since the 1960s. Numerous U.S. Forest Service projects, compliance-based projects, and museum-sponsored projects have been conducted. There is a considerable amount of archaeological information in regard to frequency of sites; however, data from formal excavations are limited. Previous research in and adjacent to the study area is discussed below.

Located at the southern end of the research area is the Rock Camp site (CA-SBR- 342), one of the largest sites on this side of the mountains to occur within the mixed conifer and oak woodlands. The site (as currently mapped) extends 325 m east to west and 150 m north to south. The site is characterized by numerous (exact numbers are not represented on the site record) mortars and



large midden deposits. Excavations sponsored by the San Bernardino County Museum between 1965 and 1969 (Hedges 1977:138) demonstrated that the site's inhabitants used local granite for milling implements and imported materials such as obsidian, chert, chalcedony, jasper, and quartz crystals for flaked stone tools (Northwest Economic Associates 2004: 55). Pottery was also present in the assemblage.

The collection from the Rock Camp excavations has prompted new investigations of the site. In a series of papers presented at the 2016 Annual Society for California Archaeology Conference, Mark Allen of California State Polytechnic University, Pomona revived the discussion concerning the site and presented new information on chronology, tool use, associated sites, and faunal remains (Allen 2016; Carmona and Allen 2016; Limahelu *et al.* 2016; Smith *et al.* 2016; James 2016). One particularly intriguing piece of data presented were obsidian hydration dates indicating occupation possibly as early as 7000 BP (Carmona and Allen 2016). Other new research examines the use of ground-stone implements (metates and mortars) at Rock Camp for processing animals in addition to plant food resources (Padilla 2017).

Wes Reeder and Tim White conducted additional research in the 1960's. In their paper *An Archaeological Survey of the Deep Creek Drainage, San Bernardino Mountains, California (1970)* they documented approximately 88 new archaeological sites in the San Bernardino Mountains. The majority of these sites (51) are located on the Lake Arrowhead Topographic Quadrangle (an

approximately 5-mile radius around Rock Camp). The records for many of these sites are lacking pertinent quantitative and interpretative data but the locations of the sites provide information in relation to the distribution of sites across the mountains. Reeder and White (1970) presented an interpretation of chronological site differentiation based on landforms. "Recent" sites are attributed to the Late Prehistoric and located adjacent to waterways, "ridge" sites are intermediate in age and located on ridge lines, and "meadow" sites located at higher elevations along the outer margins of meadows were deemed to be the oldest (Reeder and White 1970:4). The authors do not specify why they interpreted these sites to be of different age beyond the difference in landform and the "tool types" for the "meadow" designation (Reeder and White 1970:3). This interpretation is more of a hypothesis for which Reeder and White give only loose, relative time frames with no connection to actual dates. Their work, while vocational and voluntary, has contributed valuable information to archaeological site distribution.

Other valuable work from the 1960's comes from *Archaeological Investigations of the Mojave River Drainage* (Smith and Moseley 1962). This report discusses excavations at the Serrano Village site of *Guapiabit* (located at the base of the mountains adjacent to the Mojave River) that took place beginning in 1939. The report shows the physical location of the village referenced in the ethnographies by "a large number of circular pits" indicative of structures (Smith and Moseley 1962: 11). The excavated assemblage provided several interesting artifacts that lend credence to the notion of trading activity in

the region during protohistoric times and possibly earlier. Shell beads (*Olivella baetica*) were present in the assemblage, demonstrating contact, directly or indirectly through traders visiting the Pacific coast (Smith and Moseley 1962: 20). Other elements of the assemblage consist of flaked stone, milling equipment, and pottery. Another interesting interpretation offered is the presence of two distinct occupations of different ages. The earlier phase is characterized by “milling stones and handstones, scraper planes, choppers, hammers, cogged stones, and projectile points classified as dart tips” (1962: 23). The later occupation is represented by “pottery, mortars, and small arrow points” (1962: 23). If this interpretation is correct, the village would likely have been established much earlier, before the Late Prehistoric. Illustrations of projectile points recovered from the site clearly represent artifacts diagnostic of the Gypsum Complex (2000 cal B.C. – cal A.D. 200). As seen in Figure 4, point number “1” is Gypsum in form, contracting stem and dart size, point number “12” is an Elko, and point number “11” might be classified as “leaf shaped”, possibly representing the Deadman Lake Complex at the end of the Middle Holocene (1962: 30). The presence of circular pits, pottery, milling implements, projectile points, and trade items demonstrate *Guapiabit* was a Serrano village on the north side of the range. That would have been occupied primarily in the winter: “...habitation sites near the base of the mountains for winter living and at higher elevations for warmer seasons” (Northwest Economic Associates 2004: 43).

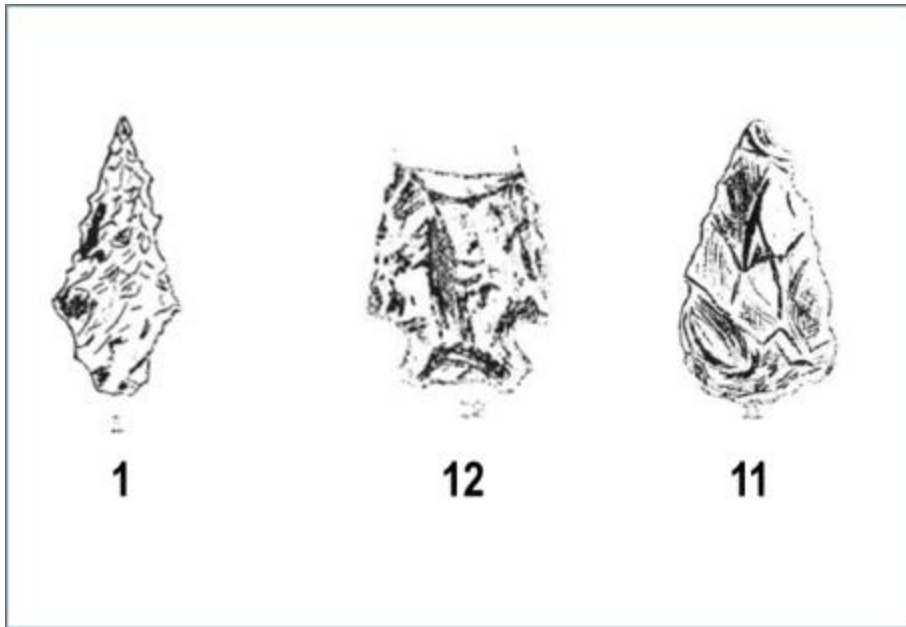


Figure 4. Illustration from Smith and Moseley 1962: 20.

The San Bernardino National Forest Service conducts archaeological investigations as part of legislative compliance, and two of these compliance project reports provide important information relative to this thesis research. *An Archaeological Survey for the Deep Creek/Green Valley Forest Health Project* (Nykamp 2006) was conducted southeast of the current research area and at a higher elevation. This research showed that the frequency of archaeological sites in that area is similar to the frequency of sites in the current research area, with 18 previously recorded prehistoric sites, three new prehistoric sites, and six prehistoric sites noted but not formally recorded (Nykamp 2006: 12, 17-26). This demonstrates the presence of sites at higher elevations than Rock Camp (4850'). This report also noted that "prehistoric trails led up almost every canyon and

crossed the forested summit country” (Nykamp 2006: 6). Considering this current research focuses on canyons as the proposed routes of travel, the quote above is important to the foundation of this thesis. An indication of trails leading up almost every canyon would lend validity to the SRI proposed model, if discovered trails we indeed prehistoric.

The second Forest Service report details test excavations conducted at two sites (CA-SBR-936 and CA-SBR-488) located in the Burnt Flats area. This area is within the current research area, and two of the proposed travel routes bound the Burnt Flats landform on the east and west. The assemblages recovered from the sites are not extensive, but support details from the ethnographic literature that indicate the Serrano practiced seasonal use of higher elevations and utilized lithics and milling implements to capture and process animal resources, specifically deer (McKay 2005: 23). Interpretation of sites in the Burnt Flats area is that local Native American people engaged in hunting and gathering activities in the Late Prehistoric (McKay 2005: i). While data from the Forest Service excavations support this interpretation, apparently the area was not used extensively enough to develop midden deposits on the scale of Rock Camp.

An archaeological field school sponsored by California State University San Bernardino and SRI was conducted in the eastern portion of the current research area in 2005 and 2006. These investigations occurred along Deep Creek north of the confluence with Holcomb Creek at sites CA-SBR-485 and CA-

SBR 425/H. This region is also the location of the Pacific Crest Trail which likely follows the same route as the prehistoric trail used to travel from the Deep Creek watershed to Bear Valley in the eastern portion of the range. The findings suggest that the sites were occupied primarily during the Late Prehistoric from A.D. 900-1400, and site inhabitants focused on plant processing and stone tool procurement. Dart points were also recovered, suggesting there may have been an earlier, small occupation (Douglass *et al.* 2009: 91). This finding is consistent with material recovered from *Guapiabit*, Rock Camp, and CA-SBR-485. Each of these sites displays primarily Late Prehistoric occupation with the potential for occupation as far back as the beginning of the Late Holocene (2000 cal B.C.).

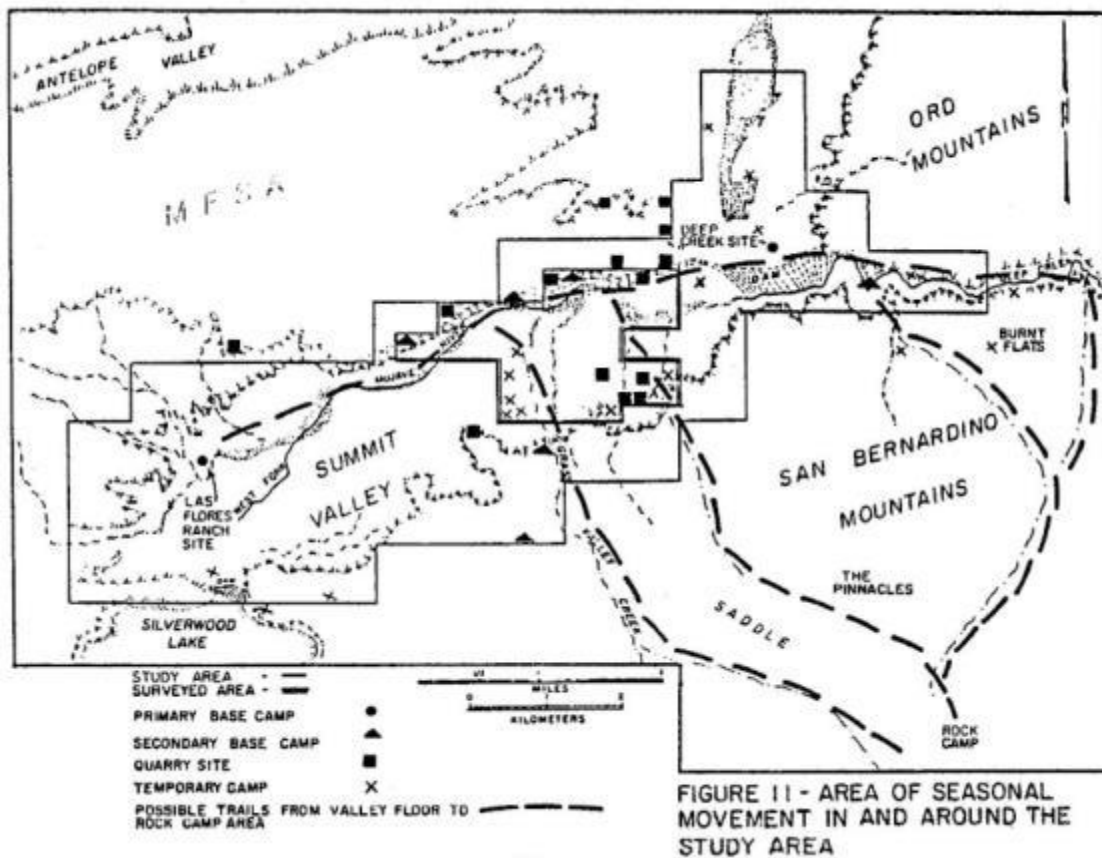
Douglass *et al.* (2009) also discuss the presence of obsidian at the sites as an indication of “long-distance trade”. As far as settlement, they suggest that the two sites fit with the Reeder and White model, where Late Prehistoric sites are located along stream terraces (Douglass *et al.* 2009: 87-91). These data are consistent with data from other locations in the mountains and in the Summit Valley. The sites at higher elevation appear to represent resource procurement on a seasonal basis.

The final two reports discussed herein are the primary sources of material from which the research design of this thesis was formulated. In 1985, SRI produced a survey report for the Summit Valley area. *Cultural Resources Investigations in the Mojave River Forks Reservoir, San Bernardino County, California* is a thorough investigation that attempted to bring regional context to

the relationship between sites in the Summit Valley and sites at higher elevations in the San Bernardino Mountains. The background information provided in the report provides extensive context for the prehistory of the area, detailing paleo-climatic conditions (Altschul *et al.* 1985: 13-19) and ethnographic information (Altschul *et al.* 1985: 28-29). This report proposed a model for the settlement and subsistence practices of the Late Prehistoric Serrano that is based on ethnographic information suggesting a seasonal round mobility pattern (1985: 68-77). The model also considered the spatial distribution of sites in the valley bottom in relation to known sites at higher elevations, most notably Rock Camp. Rock Camp was the destination (or apex) of the model presented, and four different travel routes were proposed to access Rock Camp as a primary base camp to gather resources at higher elevations (Altschul *et al.* 1985: 72) (Figure 5 and 6). The authors propose the Serrano camped at “primary base camps” (such as *Guapiabit*) in the winter, leaving in spring while “slowly making their way up to the acorns and pinyon nuts near Rock Camp by early fall” (1985: 72). This model is more extensive than the one presented by Reeder and White in 1970, with spatial, ethnographic, and resource variables providing the basis for the model.

Altschul *et al.* (1985:77) emphasize the importance of “well established paths” as being part of the mobility model for the region. They also reference a trail that connected the forks region, up Deep Creek to Bear Valley (Altschul *et al.* 1985: 28; Harrington Serrano notes, ca. 1918. appendix: 159-163). This is precisely the modern path of the Pacific Crest Trail. In the same section, another

trail is thought to have connected the forks region with the village at Rock Camp (1985: 28; Harrington Serrano notes, ca. 1918. appendix: 159-163) which is the current route of California State Highway 173.



72

Figure 5. Model of proposed travel routes (Altschul *et al.* 1985: 72).





Figure 6. Google Earth rendition of the Altschul *et al.* model.

Six years after the Mojave River Forks report one of the authors, Jeffrey Altschul, discussed some issues related to the previously proposed model in *The Deep Creek Site Revisited* (1991). This report focuses on framing future research dealing with the proposed settlement and subsistence model and points out issues with using ethnographic research. Altschul suggests that “ethnographic studies of the Serrano began long after traditional subsistence and settlement practices had ceased” and argues that this may skew interpretations of the archaeological data (Altschul 1991: 5). Altschul further states that the model was

based on known site locations, and tests of these models “often cannot be nullified” (1991: 5). He discusses the issue of carrying capacity and how there is little information with which one can begin to create population estimates. The main problem, however, is one of chronology. Late Prehistoric occupation is apparent at many sites in the region (McKay 2005; Douglass *et al.* 2009; Smith and Moseley 1962), but many of these sites also exhibit evidence of an older component (Douglass *et al.* 2009; Smith and Moseley 1962; Carmona and Allen 2016) dating as far back as the beginning of the Late Holocene. These data lead to questions concerning the antiquity of the seasonal settlement pattern proposed by Altschul *et al.* (1985) and if this pattern had roots in earlier time periods or if it is related to the change in subsistence strategies noted at the end of the Middle Holocene (Warren 2002: 138). These chronological questions create challenges for researchers wanting to consider diachronic cultural change in the region. Altschul does suggest a starting point for understanding change over time in the region and suggests that “The base camp is the logistical center” (1991: 7). Base camps were at various elevations within the range and provided the logistical center for gathering and processing in preparation for transport to lower elevation villages (occupied year round by some).

## CHAPTER THREE

### THEORETICAL FRAMEWORK AND RESEARCH DESIGN

The purpose of theory in archaeological investigations is to frame the context in which questions or hypotheses are formulated. The theoretical basis of this investigation is nested within the Human Behavioral Ecology (HBE) school of thought. HBE itself is nested within a larger Evolutionary Archaeology school of thought, the general basis of which is that Darwinian principles of biological evolution are also present on a macro-level in relation to culture (Renfrew and Bahn 2012: 473). In a very general sense, culture will make the necessary adaptations to facilitate survival based on certain variables. The definition of variables is where the various theoretical frameworks branch out within this larger field of Evolutionary Archaeology. In fields such as anthropology these alternative theoretical schools of thought are disciplines such as sociobiology, evolutionary psychology, and behavioral ecology (McGee and Warms 2000: vii).

Early manifestation of this evolutionary or neo-evolutionary (Renfrew and Bahn 2012: 473; McGee and Warms 2000: vii) school of thought were evident in cultural ecology. Standard concepts within Cultural Ecology are derived directly from Darwinian evolutionary concepts of variation, drift, natural selection, and adaptation (Johnson 2010: 171). Cultural Ecology is the belief that human culture can be studied directly in relation to the environment.

Environmental factors have some level of influence on biological organisms that must survive in any given environment. Humans are complex biological organisms, and culture must be considered an organism as well within this school of thought. Using the environment as a variable, ethnography and archaeology can seek to look for cross-cultural regularities among people living in similar environments (Steward 1955). Elements of social structure, mobility patterns, and territoriality can all be related to environmental conditions on some level. The Serrano social structure provides an example where individual clans owned property at higher elevations (Northwest Economic Associates 2004: 32). An interpretation of this structure is the separation of territories between clans within a tribe, as a mechanism to ensure that all clans will have access to sufficient resources.

Another principal of Cultural Ecology is the concept of rational exploitation of an environment. "In practice, very few human individuals or groups consciously choose a strategy that they believe or know to be a poor one" (Johnson 2010: 173). Choosing a strategy of subsistence can be viewed through a lens of energy, where the correct evolutionary strategy will be one that maximizes energy return rates while minimizing energy output (White 1946; Johnson 2010: 173). Ideas about energy and efficiency brought about the refinement of Cultural Ecology into more recent forms of these same principals, HBE and Optimal Foraging Theory (OFT), which focus on individual fitness.

When researching past cultures using HBE as a foundation, the goal is to

use a “reductionist rather than holistic” approach (Winterhalder 2000: 52). This means, one must look at individual factors of a cultural subsistence strategy in order to weigh out the costs and benefits associated with these individual factors. These concepts are frequently represented in mathematical or graphical models (Winterhalder and Smith 2000: 52). In evolutionary terms, if a certain resource exploitation strategy has a high energetic cost relative to the energetic return, the strategy will lead to diminishing returns and eventually need to be abandoned or modified. Not all resources will provide an energetic surplus, but some resources, even at an energetic net loss, need to be procured in climates where seasonality is a factor (Johnson 2010: 174). This reality is how HBE and OFT have established a number of parameters to study resource procurement.

An example of parameters used to study subsistence strategies is the Diet Breadth Model. This concept is concerned with breaking down the tasks associated with resource acquisition, resource abundance, energy produced by food items, energy needed to acquire resources, and the time required to harness energy from resources (Bettinger 1991: 84). Using the Diet Breadth Model researchers can calculate specific quantities for net energy returns in a given environment. A similar model is the Patch Choice Model which uses the spatial distribution of resources as its base consideration i.e. resource patches will inherently provide different levels of energetic return, and decisions about which patches to forage will be directly related to the amounts of energy they produce (Bettinger 1991: 89). This parameter of analysis provides a ranking

system for resource patches that provides data on which patches may be exploited before others, and at what point patches will be abandoned for more productive ones (Bettinger 1991: 92).

### Seasonal Round

Large parts of the planet are subject to seasonality, where resources are available in different areas at different times of year. Kelly's (1995:111,115) definition of a seasonal round is "hunter-gatherers move between different locations as resources come and go with the seasons". The principal idea of a seasonal round is that people must move locations in conjunction with the availability of resources. In the context of the Serrano, Altschul *et al.* based their settlement and subsistence model around the availability of certain staple plant foods as the driving force behind the patterns of movement. Based on the ethnographic and archaeological evidence, sites along the Mojave River headwaters are considered winter camps. Movement began in the spring and focused around yucca and cactus buds, while early summer provided other resources such as chia, buckwheat, and sunflowers (*Helianthus*) (Altschul *et al.* 1985: 68). These foods can be found at lower elevations up to the higher elevation mixed-conifer woodland region. Although these resources are found at a variety of elevations, Altschul *et al.*'s model considers the difference in bloom time for the plants based on

their elevation. "By the time these resources had become depleted at the lower elevations on the mountains, they were just becoming available at higher elevations" (1985: 68). Seasonal round movements (as proposed by Altschul *et al.*) would "successively" move to higher elevations, eventually resulting in occupations within the mixed conifer woodlands (such as at Rock Camp) for the pinyon and acorn harvest (1985: 69).

A seasonal round pattern is a strategy that must be flexible to adapt to changing environmental conditions. As vegetation communities change or migrate in space (such as elevation) a group must adapt their particular strategy or pattern in order to remain on the net positive side of the energy returns. "The complete range of these strategies...is manifested only over long periods of time...sometimes resulting in the complete reorganization of one seasonal round into another" (Kelly 1983: 301-302).

A seasonal round mobility pattern is a feature of hunter-gatherer practice that may not be the same or even similar from region to region. In the case of the Serrano, the model suggests they were moving to higher elevations beginning in the spring and coming back down in early winter (Altschul *et al.* 1985: 68). In contrast, the Great Basin Shoshone would winter in the mountains in the pinyon juniper woodlands and descend in the spring to valley bottoms (Kelly 1983: 115). There are also different strategies that will work in the same environments. These differences can be seen in OFT based inquiries in the Great Basin (Bettinger and Baumhoff 1982; Bettinger 1976; Hildebrandt and

Ruby: 2006). Changes in strategies were often the result of new technology or a shift toward resource intensification (Bettinger and Baumhoff 1982: 500; Bettinger 2001: 142).

If staple foods were required to sustain a population throughout the winter (Northwest Economic Associates 2004: 43), the survival of the people depended on the mobility pattern promoting successful exploitation of those resources during other seasons of the year. Focusing on the crop yield discussed in Chapter Two, understanding the movements associated with each staple crop can begin to frame a model of how humans moved throughout the mountains. Pinyon crops do not occur annually in the same locations, so sites directly associated with pinyon harvest will change from year to year. Whereas the sites directly associated with the more consistent acorn crop should be more consistently located from year to year.

The benefit of a consistent resource (acorns) located within the elevational range of a less consistent crop (pinyon) allows for flexibility in terms of mobility. Following a settlement system designed to be at the correct elevation for the acorn harvest in fall also allows for less mobility beyond the settlement system in order to locate and harvest pinyon at the same time of year. With the settlements in oak woodlands, a foraging radius around settlements would likely give access to a pinyon stand every year considering harvest times are separated by a few months maximum.



## Mobility

Mobility is a quintessential feature of hunter-gatherer society and usually essential to survival. In Lewis Binford's classic model of "Collectors and Foragers" (1980: 5-12), he provides a framework for the mobility patterns practiced by each group. Foragers use a mobility pattern where they rarely store food and move residential bases in order to "map onto" resources on an "encounter" type basis (Binford 1980: 5 and 10). In contrast, Collectors are logistically oriented to bring food to people with a settlement pattern linked to logistical forays to gather targeted foods for processing, storage, and transport to residential bases (1980:10). In basic terms, Foragers travel to resources to be utilized at their locations, while Collectors travel to resources to procure and transport back to residential bases. These two mobility patterns are not the only two systems by which hunter-gatherers procure food but are tools for conceptualizing the different forms of mobility. Later works have refined this dichotomy to illuminate the many different variations of this mobility model between the two extremes of Foragers and Collectors. Work in San Diego County has identified at least 15 different settlement dimensions within this dichotomy (Laylander 1997). Definition of the parameters of mobility can help to narrow down the many variables within mobility strategies.

Kelly characterizes five different measures for studying mobility: 1) the number of residential moves made each year; 2) the average distance moved; 3) the total distance moved each year; 4) the total area covered over the course of

a year; and 5) the average length of a logistical foray (1995: 120-121). These measures are valuable when they are available, when they are not, establishing distances moved, area covered, and length of logistical forays is difficult. A researcher must either assume archaeological site relationships or prove the assumed relationship with corresponding dates from the sites.

Other manifestations of these mobility concepts are seen in more regionally-related studies where the forager/collector model is modified to use the terms “Processors and Travelers” (Bettinger and Baumhoff 1982; Bettinger 1991; Kelly 1992). These concepts are related to OFT and they specify the strategic choices made by hunter-gatherers. Travelers will demonstrate high levels of logistical and residential mobility with a focus on high return resources and low populations densities (Bettinger 1991: 101; Kelly 1992: 46). Groups classified as Travelers will have brief durations of residency, long distances of travel, narrow spectrums of targeted resources, and higher costs associated with traveling, searching, and scouting. Processors will have long durations of residency, short distances of travel, broad spectrum of targeted resources, and high costs associated with procurement and processing (Bettinger 1991: table 4.1). These processor and traveler concepts fit well with the Late Prehistoric model for the San Bernardino Mountains where the Serrano would be classified as processors.

There are several issues with framing this research in a theoretical context using the parameters laid out above. All these relationships between the winter villages along the Mojave River and Rock Camp are hypotheses. This is not to

say the relationships were unlikely but rather demonstrating the problem with using the parameters of mobility studies recommended by Kelly (1995: 120-121). If we assume that people wintering along the river were the same as those utilizing Rock Camp, we have at least two residential moves per year. In contrast to this model of two residential bases, Altschul *et al.* indicate there might have been many more residential bases located at different elevations (1985: 69). There is a problem with measuring mobility if one cannot be certain how many residential moves were made or how far apart the settlements were. These concepts for studying mobility are much more suited for ethnographic studies rather than archaeology. However, there are other methods by which researchers can formulate questions to look at mobility in prehistory.

A Geographic Information System (GIS) is a tool demonstrating many different avenues of inquiry related to mobility. Using modern software, researchers can use a wide variety of tools to model human mobility patterns. One of the benefits of utilizing GIS is the comprehensive aspect, where site locations, digital elevation models, aerial photos, and vegetation density maps can be combined. Understanding and modeling human movement using GIS is something that archaeologists are constantly attempting to improve.

More recently the application of Least Cost Path (LCP) analysis has presented interesting opportunities to study mobility (Wood and Wood 2006; Morgan 2007; Howey 2011). LCP analysis is a GIS-generated path of travel based on factors such as slope, distance, and difficulty (density of vegetation). In

areas such as the Sierra Nevada Mountains, specific behaviors can be attributed to sites; foraging radii can be modeled to show how far people were foraging out from certain locations (Morgan 2007). In the frame of HBE, LCP is the most efficient means to travel between two points. Howey defines the application: "...the optimal path of travel can be calculated by finding the one [path] that passes between points with the minimum accumulation of these impediments [geographic features] or 'costs'" (2011: 2524). LCP is an effective tool for modeling human movements, but it comes with flaws.

One issue where LCP falls short is considering how cultural phenomena can have an impact on how humans move. Elements of economics, territorial boundaries, and conflict are not included in these models as they only predict energetic efficiency of travel (Verhagen 2010: 383). On a more technical basis, criticism of LCP can be seen in errors or differences in software used by different researchers (Herzog and Posluschny 2008: 236). If resolution of a digital elevation model is poor, calculations of slope can vary from one computer program to another (ibid.: 236). While LCP can be useful, it can fail to illuminate subtle factors that might influence human movement. With mobility being linked to hunter-gatherer life-ways, the act of moving, regardless of need, is in many cases ingrained into the ethos of a people (Kelly 1995:152-153).

Bearing in mind these ideas, this research attempts to combine simple theoretical ideas with replicative action. Ethnographic information has provided some indication of the mobility practices of the Late Prehistoric Serrano in the

Upper Mojave River. The geospatial distribution of archaeological sites in the region seems to fit well with the ethnographic literature. However, the details of the area are interpretive predictions which require verification and correlation to the ethnographic work. Taking the proposed travel routes from Altschul *et al.*, one could easily run an LCP analysis in order to identify the efficient ways to reach higher elevations. To add more to the archaeological record, computer models would fall short in gaining further insight to the plausibility of the mobility pattern. Replication of the mobility pattern will help to identify the most efficient route upwards and provide interpretative measures to expand this pattern to a larger breadth in the range. One would expect to find more archaeological sites along the most efficient route.

### Research Design

The design of this research project is based on two fundamental factors; energetic output associated with travel, and analysis of the archaeological sites associated with the settlement model as currently defined. The mobility model proposed by Altschul *et al.* (1985) presents a physical map of proposed travel routes used by the Serrano in the Late Prehistoric period (see Figures 5 and 6). In addition to the Altschul *et al.* model, the ideas presented by Reeder and White (1970) loosely define landform associations for settlement patterns. These two are the only existing models specific to the San Bernardino Mountains along the

Deep Creek watershed.

This research focuses specifically on the Altschul *et al.* model as a testing mechanism. Looking at the model in the framework of HBE and OFT, this research project aims to evaluate which of the proposed routes is the most efficient in relation to energy expenditure. If we accept basic principles of HBE and OFT, the choice of route used should be the one with the least amount of energy required to traverse it. "Optimization pertains to the efficiency, relative to the time or energy costs, ...with the assumption that increased efficiency relative to a standard of performance leads to a relative increase in fitness" (Winterhalder and Smith 1981: 15). Efficiency in the context of the Altschul *et al.* model pertains to the choice of travel route to access higher elevations.

Energetic output is an element of human behavior that has not changed as drastically over time in comparison to other behaviors such as food acquisition. Modeling the biomechanics of human mobility and the energy costs associated with mobility has been done (Pontzer 2007; Pontzer *et al.* 2009). However, there is more utility in the simplicity of physically replicating the mobility pattern due to the fact that additional archaeological sites may be discovered.

The major issue with the Altschul *et al.* model is that it only includes a small portion of the archaeological sites in the region. Additional fieldwork is still needed to gain perspective on the region outside the spatial boundaries of the Altschul *et al.* model. We know there are more sites along the Deep Creek drainage and the task is to explain how the Altschul *et al.* model represents the

settlement system. Is the Altschul *et al.* model a branch of a larger system or do the archaeological sites outside the Altschul *et al.* model represent another clan territory or different time period? The archaeological sites in this research will be analyzed to differentiate residential sites from other site types. Looking only at the sites within the spatial boundaries of the Altschul *et al.* model would significantly lower the sample size of sites and disregard the most substantial water source in the region. Knowing if the Altschul *et al.* model is a representation of a single clan territory is or otherwise is outside the scope of this research.

Keeping the above questions in mind, the following research questions are presented as the primary focus of this research project.

- 1. Which of the Altschul *et al.* travel routes is the most efficient in terms of energetic/caloric output?**
- 2. Of all the routes investigated which one has the most archaeological evidence of use? And, is that route within the spatial boundaries of the current model?**

Evaluation of the first research question requires data directly related to energetic/caloric output to facilitate comparisons between routes, along with analysis of the current spatial distribution of archaeological sites. Physiological data gathered requires consistency across the routes with controls regulating any potential variability across the dataset. If routes are to be compared, these data must be consistent in terms of collection methods. Energy expenditure can vary

based on methodological choices. For instance, if different amounts of weight are carried on different investigations the energetic output will vary. Jogging on a route will increase the energetic output compared to walking. Addressing the question of energy, the validity of the evaluation rests on the consistency of the methods.

Evaluation of the second research question(s) requires a combination of the physiological data and archaeological data. Existing archaeological sites and potential new archaeological sites will inform the evaluation of route use in prehistory. The archaeological site types will also need differentiation to gauge which sites display characteristics of residential use and which display characteristics of temporary or specialized use. Archaeological sites can inform interpretations both within and beyond the spatial boundaries of the Altschul *et al.* model. This evaluation of archaeological sites and site types will aid in answering how the Altschul *et al.* model fits into the surrounding region in terms of prehistoric settlement and mobility patterns. Site types and locations should also be compared with the physiological data to either support or refute the predictions presented in this research design.

### Test Implications

The first research question, *which of the Altschul et al. travel routes is the most efficient in terms of energetic/caloric output?*, will be tested using the



theoretical principal of efficiency. The second research question requires similar evaluation in terms of both physiological and archaeological data. If a distinction can be made of likelihood of route use within the four proposed routes of the Altschul *et al.* model, another route or routes should be evident as means of access to the other archaeological sites in the research area. If there is another route accessing different portions of the research area (outside the Altschul *et al.* model), this other route should display efficient energetic requirements and high relative frequency of archaeological sites.

A negative result will indicate the principals of OFT may not be accurate for this particular research area. Results indicative of refuting the efficiency principle would be a high frequency of archaeological settlement sites along a route with high energetic requirements relative to the other routes. If negative results are discovered, external factors, possibly environmental or cultural, would need to be investigated using an alternative research design and likely a different theoretical framework.

## CHAPTER FOUR

### METHODS

The design of the project is based on the replication of mobility in a mountain environment. The methods are designed to minimize variability in data gathered and provide the opportunity to add more data to the archaeological record. Modern conveniences allow humans to be more comfortable while traveling difficult terrain. Modern equipment allows researchers to gather large quantities of physiological data easily. For this study, basic controls were designed to keep physiological data consistent. Nevertheless, the attempt to replicate mobility patterns is experimental so a clear objective must be followed to gather consistent data.

Fieldwork was designed to provide both quantitative and qualitative data for interpretation. The basis of the field investigation was to travel all the proposed routes on foot while gathering physiological data in order to measure the efficiency of each route. In addition to the routes proposed by Altschul *et al.* a length of the Pacific Crest Trail was walked outside of the spatial boundaries of the model both in order to evaluate the efficiency of the route along Deep Creek (the only well-established trail in the area) and to gain a broader perspective on the settlement system for the region (Figure 7).

The fieldwork consisted of a modified archaeological pedestrian survey where the goal is to travel distances rather than conduct more formal

standardized transects. Each route was investigated on foot from the lowest elevation to the highest and back down in elevation again or in the opposite order (highest to lowest and back up). Any archaeological sites discovered during survey were mapped with GPS and notes taken regarding potential site type or function. Given the research goals, any new sites discovered were not fully documented in the interest of maintaining pace for the quantitative data. After completion of all field investigations the data were compiled into two tables for comparison and analysis.

The routes presented by Altschul *et al.* have been assigned names for tracking purposes that are directly related to the geographic names associated with the routes' proposed locations. These names are Grass Valley Creek, Pinnacles South, Upper Kinley, Lower Kinley, and Burnt Flats West (Figure 7). The additional investigation outside the spatial model is named Pacific Crest Trail (PCT) or the Deep Creek Route. All the investigations have two separate data sets (ascending and descending) relative to the elevation. The device used for gathering the physiological information also tracks GPS position which gives an accurate plot of the direct path of travel.



Figure 7. Map of proposed routes and additional Pacific Crest Trail/Deep Creek route.

Completion of the field work resulted in a data set directly related to the energy efficiency of travel. Using existing archaeological site records, the most efficient route can then be compared to the abundance of archaeological sites for verification. The data was viewed in relation to the amounts and types of obstacles encountered, presence or absence of resources (water and plant foods), levels of exposure to sun and wind, and the overall difficulty associated with each route.

This investigation was undertaken by only one field researcher, so any form of systematic archaeological survey is outside the scope of the research. Since the proposed routes vary in distance and direction, the only archaeological sites documented were the ones encountered while maintaining the traveling objective. No archaeological sites were documented fully; just a GPS position taken and notes taken regarding possible site type and function. If one is constantly stopping to take notes and fully record sites, the physiological data will not represent traveling mobility. Heart rate would drop while recording sites and additional calories would be burned while walking around a site. Video was the primary means of documentation, allowing for a constant stream of notes to be verbalized to the camera while walking. Finally, it was important to avoid getting side-tracked by inviting landforms, rock shelters, or any other landscape features that would interrupt travel.

### Logistics

All of the proposed routes were investigated in single-day field sessions. The remote location of these proposed routes caused logistical issues related to access and safety. The only access to these routes is either from the bottom of the range in Summit Valley or at higher elevations along Highway 173. Rock Camp is easily accessible; one can park directly adjacent to the site. Pinnacles South and Grass Valley Creek are the two routes where Rock Camp is the

starting point. Upper Kinley is directly adjacent to Highway 173 and was investigated from the divergence of Kinley Creek and an un-named drainage running down the west side of Burnt Flats. The higher elevation portion of Upper Kinley is not accessible due to the presence of a shooting range. Burnt Flats West and Lower Kinley are both accessible from the same divergence of the above-mentioned drainages. This creek divergence area is the southern extent of the Burnt Flats landform and served as the starting point for Upper Kinley (going up and coming back down), Burnt Flats West (going down and coming back up) and Lower Kinley (going down and coming back up). The PCT route was investigated from the Splinters Cabin area at the confluence of Little Bear Creek and Deep Creek. The PCT investigation proceeded from this confluence down Deep Creek 5.5 miles and back up.

Due to the length of one route, Pinnacles South, the route was broken into two separate investigations. The upper section of the route was investigated from Rock Camp to the apex of the route (higher in elevation than Rock Camp). Even though this section gained in elevation, it is actually a route down the mountain where one must gain elevation until the apex and then proceed down the mountain. The lower section of the Pinnacles South route was investigated from Summit Valley up to the desired destination of the apex (the stopping point of the Upper section). Kinley Creek was also separated into upper and lower sections due to the joining of Burnt Flats West and Lower Kinley routes. The Upper Kinley route serves as the upper section of both Burnt Flats West and Lower Kinley

routes. Grass Valley Creek was investigated from Rock Camp down to Summit Valley and back up.

Considering the remote nature of central portions of the routes, safety precautions were set in place in the event of an emergency. Food and minimal shelter was carried in the case becoming stranded or lost. First-aid supplies were carried on each investigation in case of injury. Much of the research area has poor cell reception so locational information of the drainages and routes was provided to acquaintances prior to each field investigation. These acquaintances were directed to come looking or notify Search and Rescue in the event of no communication or lack of return after 10 hours from starting the investigation. The investigations were not all conducted in successive days but rather on days when weather and work permitted.

### Controls

In order to maintain consistency in the physiological data, standard controls were developed and implemented during investigation. The controls were designed to minimize the use of modern conveniences that make travel easier and more efficient for modern humans. These controls focus on energy and first-person navigation. The first control is related directly to energy and the intention to not allow for boosts in energy levels. No food was eaten either before (morning of) or during any of the field investigations. This control is primarily in

recognition of the modern diet and easy access to high calories foods. Having the benefit of eating during investigations would have provided boosts in energy levels and possibly affected the exertion levels needed. Also, eating high calorie foods on field investigations could lead to an underestimation of the difficulties required to walk the routes. Rather than attempt to replicate a prehistoric diet it was decided to eliminate the variable of food entirely. Only water was consumed during the investigations. Of course, prehistoric people would obviously have had food and there is no shortage of plant foods along the routes.

Second, the amount of weight carried on every investigation was the same in order to keep the exertion levels consistent across the data set. The weight carried (8181grams) was intended to be as light as possible while allowing certain safety equipment in the case of an injury or emergency. Food was carried but was only to be eaten in an emergency. The items carried comprised basic gear designed to provide safety (first aid kit, emergency equipment, water, compass) and the equipment needed to gather data (GPS, camera gear, notebook).

Modern technology provides many navigational advantages that were lacking in prehistory. Therefore, for the third control it was decided that no maps (satellite, topographic, or documents with plotted sites) were to be carried during the field investigations, forcing all navigational decisions to be made based on field of vision alone. Not knowing if any sites encountered had been previously



recorded would help to avoid actively trying to locate known site, as well as keep navigation expectations in line with the field-of-vision objective

Forth, all investigations proceeded without stopping for more time than was needed to recover from the exertion of traversing difficult sections of each route. This control was not intended to facilitate a time trial but rather to keep from stopping to take notes or fully record sites. Stopping was only permitted when exhaustion became severe, necessitating a few minutes of rest to regain breath. The fifth and final control is directly related to the previous one in that pace should be controlled in order to keep the physiological data consistent. The desired pace of travel is a casual walking pace, between 1 and 2 mph. No running, jogging, or any other accelerated form of mobility was allowed. Also, it is assumed that seasonal movement of prehistoric people would have been similar in pace to a casual walk.

### Equipment

The main piece of equipment used for gathering the physiological data was a Garmin Forerunner 15. This is a watch worn on the wrist accompanied by a heart rate monitor worn around the chest directly on the skin. This device tracks GPS position, heart rate (average and maximum), distance traveled (miles), elevation gained and lost, maximum and minimum elevation, pace (mph), time, and calories burned. The Garmin Forerunner 15 has eight hours of battery

life, so all investigations were conducted within the eight-hour window. The eight-hour battery life allowed for a maximum four hours of one-way travel before turning back to either come back up or down. The Garmin Forerunner 15 provided the physiological data necessary to facilitate the efficient analysis of routes. A Garmin 60CSx GPS unit was also used to record Universal Transverse Mercator (UTM) coordinates. All UTM coordinates were taken using NAD 83 coordinates datum.

The camera used on the investigation was a GoPro Hero 2 mounted on a walking stick. The camera served two separate functions: 1)the provision of video documentation of sites and any notes taken regarding cultural materials and/or features observed; 2)the provision of real-time interpretations while in the field to be referred back to after completion of fieldwork. The presence of the camera also provided some level of safety in terms of alerting any potentially dangerous animals of my presence. By talking to the camera, noise beyond my footsteps would carry sufficient distances to alert wildlife prior to an encounter. The study area is home to black bear, mountain lion, and bobcat, animals potentially dangerous if surprised by a lone hiker in rarely visited areas.

## Mapping

The GPS tracker on the Garmin Forerunner 15 served as the main mapping tool to track the exact path of travel. This feature is designed to record a

GPS position every 30 seconds which can be uploaded from the watch onto the Garmin Connect software and website. The Garmin Connect website organized all the data for a given session. The information is displayed graphically, numerically, and on a map. The track can be directly exported to Google Earth Pro, which is the software used for mapping the project and allows for multiple layers to be displayed on the same satellite image in three dimensions. Google Earth Pro also provides the opportunity for importing GIS layers. Previously recorded site boundaries were obtained at the Forest Service Supervisors Office in San Bernardino, California. The site boundaries provided the geospatial distribution of sites along and around the proposed routes.

## CHAPTER FIVE

### RESULTS

Physiological and archaeological data were gathered. The physiological data will be presented first with the data sets separated into up (gaining elevation) and down (losing elevation) groupings for each route investigated. The archaeological data will be presented next outlining all the archaeological findings for the project. Finally, a combination of physiological and archaeological data will be presented specific for each route.

The physiological data represent a wide range of energy expenditures between different routes. The Calories Burned Per Mile (CBPM) ranged from 266.9 – 773.9, showing large differences in the energetic costs associated with each route. Other measures, such as time and distance, demonstrate variation of travel between routes. The archaeological findings comprise nine new archaeological sites, two of which are likely previously recorded sites where site boundaries need to be amended while seven of the sites are new. Each route required different levels of energy and presented vastly different challenges in relation to obstacles.

Due to the logistics associated with the fieldwork, the routes traveled varied in distance and difficulty. Three of the surveys were not completed to the desired length. The desired length was related to elevation or connection to existing trails. The PCT runs up the Deep Creek drainage; with the ethnographic

mention of this trail (Altschul *et al.* 1985: 28; Harrington Serrano notes, ca. 1918. appendix: 159-163), it was a desired stopping point for two of the routes, Lower Kinley and Burnt Flats West. Other goals were to reach Summit Valley along the Grass Valley Creek and Pinnacles South routes. Due to the distance and difficulty, Pinnacles South had to be walked on two separate occasions, once from Rock Camp down as far as possible (named Upper Pinnacles South) and once from Summit Valley ascending (Lower Pinnacles South) as far as possible. Upper Kinley is the section between Rock Camp and where Burnt Flats West and Lower Kinley diverge, creating one upper route for two lower routes. I was not able to connect Upper Kinley to Rock Camp due to the presence of a shooting range and restricted access. The length of the PCT was conducted from an easily accessible area outside of the spatial boundaries (east and upstream) of the Altschul *et al.* model.

### Physiological Results

The physiological results from eight separate days of fieldwork can be viewed in Tables 2 and 3 below. Each of the eight days was divided into two separate data sets, ascending in general elevation (Table 2) and descending (Table 3). The only data sets that were not planned are the Exploratory up and down sets. This was a spontaneous survey where an inviting route was pursued out of curiosity.

Table 2. Physiological results on investigations gaining in elevation.

Route	Distance (miles)	Time	Calories Burned	Calorie Burn Per Mile (CBPM)	Average Heart Rate (bpm)	Max Heart Rate (bpm)	Elevation Gained	Elevation Lost	Max Elevation	Minimum Elevation	Pace (mph)
<b>PCT</b>	5.43	2:26:13	2235	411.6	159	181	2029'	1340'	4716'	3902'	2.2
<b>Lower Pinnacles South</b>	3.74	2:28:55	2202	588.8	155	184	1984'	501'	4725'	3185'	1.5
<b>Upper Pinnacles South</b>	2.5	1:21:27	1016	406.4	138	180	210'	632'	5087'	4746'	1.8
<b>Lower Kinley</b>	2.33	1:17:55	1216	521.9	161	188	1188'	182'	4471'	3325'	1.8
<b>Burnt Flats West</b>	2.95	1:57:58	1814	614.9	165	190	1334'	278'	4471'	3253'	1.3
<b>Upper Kinley</b>	1.6	00:51:09	623	389.3	136	176	379'	133'	4763'	4438'	1.9
<b>Grass Valley Creek</b>	4.36	2:56:04	2951	676.8	169	183	1734'	378'	4880'	3371'	1.45
<b>Exploratory</b>	2.3	2:12:45	1780	773.9	147	180	708'	88'	4972'	4352'	1

Note- Elevation gained and lost is relative to actual movement up and down hills while traveling in one general direction. So traveling up in elevation can still yield substantial losses in elevation when hills are encountered.

Table 3. Physiological results of investigation losing elevation.

Route	Distance (miles)	Time	Calories Burned	Calorie Burn Per Mile (CBPM)	Average Heart Rate (bpm)	Max Heart Rate (bpm)	Elevation Gained	Elevation Lost	Max Elevation	Minimum Elevation	Pace (mph)
<b>PCT Down</b>	5.5	2:12:20	1468	266.9	129	167	1378'	1988'	4729'	3946'	2.5
<b>Lower Pinnacles</b>	3.4	1:45:11	1466	431.1	149	174	425'	1908'	4729'	3186'	1.9
<b>Upper Pinnacles South</b>	3.12	1:33:00	1152	369.2	134.5	185	450'	303'	5035'	4764'	1.45
<b>Lower Kinley</b>	3.02	1:59:56	1379	456.6	137	180	482'	1498'	4379'	3327'	1.6
<b>Burnt Flats West</b>	2.8	1:25:15	1199	428.2	150	190	265'	1379'	4473'	3252'	2
<b>Upper Kinley</b>	1.59	00:44:16	507	318.9	131	155	147'	394'	4756'	4436'	2.2
<b>Grass Valley Creek</b>	4.27	2:25:29	1786	418.3	133.5	163	161'	1604'	4871	3367	1.65
<b>Exploratory</b>	2	1:23:41	1173	586.5	151	175	105'	707'	4972'	4352'	1.4

Note- Elevation gained and lost is relative to actual movement up and down hills while traveling in one general direction. So traveling down in elevation can still yield substantial gains in elevation when hills are encountered.

Table 2 illustrates the range of physiological demands required for traversing the proposed routes while ascending the mountain or gaining elevation. The distances range from 1.6 miles to 5.43, miles and the length of time required ranges from 00:51:09 to 2:56:04. Total calories burned range from 623 to 2951, while the CBPM ranges from 389.3 – 773.9. The average heart rate falls within a 33 (beats per minute) range (136-169 bpm) and the maximum heart rate range is more constrained into a 14 bpm range (176-190 bpm). The desired controlled pace (between 1 and 2 mph) was successful on all routes except one (PCT), due to the presence of a well-established trail which made walking much easier and faster. A point of interest presented by these results is the lack of correlation between elevation gain and energetic requirements. The PCT investigation was the highest in elevation gain (2029') but boasts the third lowest CBPM number at 411.6. Conversely, the Exploratory investigation has the second lowest elevation gain (708') while boasting the highest CBPM 773.9.

Table 3 illustrates the range of physiological demands required for traveling the routes descending the mountain and losing elevation. The distances range from 1.59 miles to 5.5 miles, while the time spent traveling ranges from 00:44:16 to 2:25:29. The total calories burned range from 507 to 1786, and the CBPM ranges from 266.9 to 586.5. The average heart rate ranges from 129 bpm to 151 bpm and the maximum heart rate ranges from 155 to 190. The desired controlled pace (between 1 and 2 mph) was exceeded on two investigations, PCT and Upper Kinley. This was the result of the presence of a well-established



trail in the case of the PCT, and the gentle slope and lack of dense vegetation on Upper Kinley. Again, we can see the lack of correlation between elevation and CBPM, with the PCT investigation having both the most elevation gained (1378') and the most elevation lost (1988') in one direction and ranks as the lowest CBPM requirement at 266.9. The Exploratory route has the lowest elevation requirements, 105' gained and 707' lost but boasts the highest CBPM number at 586.5.

The physiological data illuminate the wide range of variables that impact the energetic requirements for traveling the routes. Ease of travel has the most dramatic impact on energetic requirements as evidenced by the results of the PCT investigation where the distances and elevation gains are the highest but the CBPM is comparatively low. This is a direct result of ease of travel, with the presence of a well-established trail allowing one to travel further and at a faster pace relative to caloric expenditure. Indicating travel in prehistory would preferably be on trails based on OFT. Another illuminating factor is the high energetic requirements for traveling in areas with no established trails. The Exploratory investigation covered a relatively short distance (2.3 miles going ascending and 2 going descending) with low elevation gains and losses, but the CBPM is the highest of both data sets (773.9 ascending and 586.5 descending). This was due to dense vegetation and having to climb over numerous boulders to travel the drainage.

## Archaeological Results

The archaeological findings present only a small representation of the cultural constituents that are likely present on the new sites. In all cases, once cultural material was discovered, a GPS point was taken, a few notes mentioned to the camera, and travel was resumed. The archaeological findings are presented in Table 4. The acronym “EAM” at the beginning of the temporary site designation is my initials followed by sequential numbers. The numbers were assigned after the fieldwork was completed; the order of the numbers does not reflect the order in which the sites were found.

Table 4. New archaeological sites.

Temporary Site Designation	Site Description	Comments
EAM-01	Mano, Quartzite Cobble Tool, Midden	Likely associated with CA-SBR-00492 which is within 200m to the SE
EAM-02	Quartz Debitage	Large amounts of broken quartz coming down the hill to the south. Could be quarry type site further up on the hill.
EAM-03	Chert and Quartzite Debitage	Area has extremely good vantage and many rock shelter type locations in the surrounding hills.
EAM-04	Meta-volcanic Debitage	Small lithic scatter on the periphery of Saddle landform
EAM-05	Midden	Possibly is CA-SBR-00491, and is plotted incorrectly in Forest Service GIS
EAM-06	Midden and Quartzite Debitage	Area is a nice stream terrace with sites both up and downstream of this location

EAM-07	Midden, BRM, Debitage of multiple Materials	Very likely that this is CA-SBR-00921 and the boundary is incorrect.
EAM-08	Midden	Likely a buried site. Large alluvial fan with midden eroding out of the bank.
EAM-09	Bedrock Milling	Likely buried component due to alluvial soils coming down creek and slope to the North

Two of the sites (EAM-05 and EAM-07) are very likely extensions of existing sites CA-SBR-491 and CA-SBR-921, respectively. These were instances where cultural material was observed, but plotting the positions on Google Earth revealed that they were in close proximity to the previously recorded sites. If these sites are in fact previously recorded, site boundaries should be revised to encompass the constituents found during this investigation. Three of the nine sites are located in areas that are not on any of the proposed routes. EAM 02 was discovered on the Exploratory investigation and is likely associated with a quartz vein higher up on the hillside above where thedebitage was observed. EAM-05 is located in the Burnt Flats area and, as mentioned above, is likely previously recorded. The location of Burnt Flats is between two routes, Burnt Flats West and Lower Kinley, and could represent an alternative route to Lower Kinley east of Burnt Flats; this will be detailed in the results for Lower Kinley. EAM-08 is located along the PCT and though not included in the proposed model, is along the ethnographically discussed trail leading to Bear Valley (Altschul *et al.* 1985: 28; Harrington Serrano notes, ca. 1918. appendix: 159-

163). All other sites (EAM-01, -03, -04, -06, -07, and -09) were discovered while walking the proposed routes.

### Route Specific Results

The results presented below are specific to the individual route investigations and combine the archaeological and physiological results. Thereafter, an analysis pertaining to evidence of use as a travel route in prehistory will be presented. For simplicity's sake, the prehistoric site types will be narrowed to two types: Settlement and Satellite. Clear site type differentiation is lacking in the local literature. The Altschul *et al.* (1985) report designates four different site types; Primary Base Camps (Village sites), Secondary Base Camps (camps along the travel routes), Temporary Campsites (sites not tethered to a specific route of travel), and Quarry sites (lithic procurement). The Reeder and White report identifies three separate site types, "recent", "ridge", and "meadow" (Reeder and White 1970: 3). This analysis is only concerned with the Late Prehistoric so the characteristics of the "recent" site types will be taken into consideration. The most valuable factor from the Reeder and White model will be the presence of sites on "stream terraces".

Settlement sites, as defined for the purposes of this analysis, are characterized as sites located adjacent to drainages or "stream terraces" containing midden deposits, a diversity of lithic materials, bedrock mills, and

other settlement like features (e.g. house pits). The designation of Settlement in this analysis will include sites characterized as Primary and Secondary base camps in the Altschul *et al.* model. The designation Satellite will encompass all other sites such as small lithic scatters, sites not directly adjacent to stream terraces, and/or sites without midden deposits existing outside of the primary paths of mobility and settlement. The new sites discovered on the investigations were excluded from these distinctions because there was not enough time to establish the entirety of the site constituents with the exception of one site, EAM-07, which is likely CA-SBR-921, where I observed all of the requisite characteristics of a Settlement designation.

### Pinnacles South

The Pinnacles South route is the only route which does not exactly follow a geographic drainage (Figure 8). The route is also unique in that the highest elevation reached (5087') is actually higher than Rock Camp. When ascending from Summit Valley, once one reaches the Saddle near the Pinnacles, the rest of the journey to Rock Camp is downhill. The Saddle is one of only three geographic features mentioned in the Altschul *et al.* model (1985: 72) (see Figure 5), the others are Burnt Flats and the Pinnacles. Due to the length of this route (over 7 miles), the route was split into two separate investigations, Upper and Lower Pinnacles South. A combination of battery life of the Garmin Forerunner

15 and exhaustion (a non-quantifiable factor in the physiological data) resulted in a 650m gap left un-surveyed between the Upper and Lower sections (Figure 9). The Upper portion of the route began at Rock Camp and proceeded 300m west of the Saddle before turning back. The Lower portion of the route began in the Summit Valley bottom and extended as far up as possible toward the end of the Upper route.

The Upper portion of the route resulted in different lengths due to route choice. Going from Rock Camp up to the Saddle was a distance of 3.12 miles and coming back down was only 2.5 miles. This was not a conscious choice while surveying, but rather an opportunistic result when a more direct route back to Rock Camp was sought. To avoid confusion, it must be reiterated that Rock Camp is lower in elevation than the Saddle area, so although the route is shown on Table 3, it is actually gaining elevation. The opposite is true for Upper Pinnacles South on Table 2, where this route is actually going down in elevation. The CBPM for these surveys is 406.4 while coming from the Saddle to Rock Camp and 369.2 while going from Rock Camp to the Saddle. This investigation discovered two new archaeological sites (EAM-03 and 04) which are both located near the Saddle area (Figure 8 and 9).

The lower portion of this route was one of the more challenging investigations in terms of caloric expenditure. The CBPM while ascending from Summit Valley up the mountain was 588.8 and 431.1 while descending. Also, the total calories burned while traveling up were 2202, and the desired destination

was not reached. Considering there was no direct geographic drainage to follow from the Summit Valley floor, a length of the PCT was walked until a feasible landform was found in order gain substantial elevation. The landform chosen was a ridge line without the presence of which the investigation could not have been attempted. Also, a recent wildfire (the Pilot Fire) provided areas clear of chaparral through which to travel. No new archaeological sites were discovered on this portion of the route. The lower portion of the route also resulted in the second-most elevation gained on any of the investigations (1984'). In contrast, the most elevation gained was on the PCT route (2029') and the CBPM was only 411.6, demonstrating the difference between on-trail and off-trail travel.



Figure 8. Pinnacles South investigation. Upper and Lower sections.

A combination of Upper and Lower routes resulted in a combined CBPM of 497.6, and the route was not completed. The calorie expenditure on the lower portion of the route resulted in the third highest total of any of the investigations (2202). Speaking directly to efficiency, this route is difficult with a CBPM that would have been potentially higher if the route was completed. The Upper portion of the route is much less energetically expensive due to the loss in elevation on the final leg of the route (CBPM 406.4). There is substantial elevation gain on the Lower portion of the route (1984'), with 450' in elevation gain left un-investigated.



The combined CBPM is above the average of 478.7 across the data set and cannot be evaluated on the CBPM number alone.

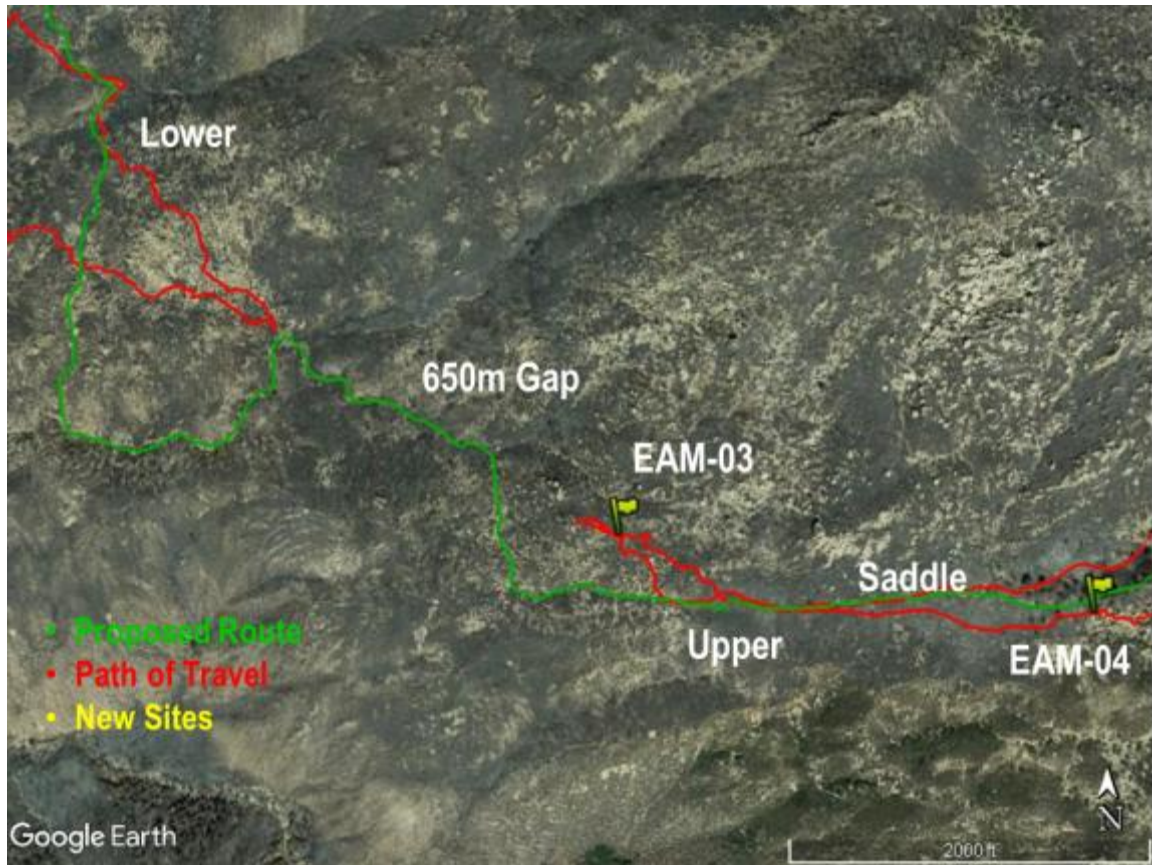


Figure 9. Pinnacles South investigation. 650m gap of uncompleted survey.

The archaeological evidence for use along Pinnacles South is poor with only two archaeological sites existing along its length. The two sites, EAM-03 and EAM-04, were not investigated enough to be classified as Settlement sites. Both are small lithic scatters where very little cultural material was observed and

appear to lack midden or bedrock mills. There are no previously recorded sites along the length of the route, only Rock Camp at the top and three sites at the bottom (CA-SBR-4178, 4184, and 5462) in Summit Valley. Further, there are no substantial water resources along this route. The many drainages travelling west out of the Pinnacles are seasonal, with water in the winter and during rain events, but none of the drainages currently flows year-round.

Looking at the Pinnacles South route in the context of Settlement and Satellite sites, there are no Settlement sites along the route (Table 5), only Rock Camp at the top, Summit Valley sites at the bottom and two inconclusive new sites located roughly half way up or down the route.

Table 5. Site types present along the Pinnacles South route.

Sites	Landform	Bedrock Milling	Midden deposits	Diversity of Lithics	Other Settlement Features	Settlement/Satellite
EAM-03	mid-slope	No	No	No	No	Unclear
EAM-04	saddle	No	No	No	No	Unclear

### Upper Kinley

The section of Kinley Creek between Rock Camp and the southern extent of the Burnt Flats area is Upper Kinley Creek. This route could not be investigated in full due to the presence of a shooting range and the direction of fire is precisely toward the creek. This investigation began south of the

divergence of Kinley and the un-named drainage west of Burnt Flats and proceeded south (ascending in elevation) toward Rock Camp (Figure 10). Once the boundary of the shooting range was reached, the equipment was reset and I came back down. This route resulted in low CBPM numbers: 389.3 ascending and 318.9 descending. This is a result of the gentle slope and relatively sparse vegetation along the creek. Two previously recorded sites, CA-SBR-468 and -492, exist along this route and one new site, EAM-01, was discovered during the Exploratory investigation, but is along the Upper Kinley route. EAM-01 is not far from CA-SBR-492 (85m to the north) and the sites are likely associated. Also, CA-SBR-492 is one of the largest previously recorded sites encountered during field investigation and has a very large midden deposit. Upper Kinley is the route where two of the other routes (Burnt Flats West and Lower Kinley) converge and proceed up to Rock Camp.



Figure 10. Upper Kinley investigation.

### Lower Kinley

Lower Kinley follows Kinley Creek from the divergence with the un-named drainage west of Burnt Flats and proceeds down the east side of Burnt Flats to Deep Creek (Figure 11). The route is another instance where the descending route was different from the ascending route. This was due to the presence of a large cliff/waterfall encountered 200m north of CA-SBR-457, necessitating a route change. Lower Kinley is considered impassable without the assistance of ropes to get past the cliff/waterfall. I had to climb up out of the creek bottom to

the east side of Burnt Flats to continue the investigation. Once up on Burnt Flats I discovered a ridgeline that provided easy access down to Deep Creek. The CBPM while descending the route was 456.6 and 521.9 ascending. I was interested to find that it took less time to come back up than it took to descend (42 minutes less). This is a result of the discovery of the ridge line and using Burnt Flats to return rather than the creek bottom.

One new archaeological site was encountered while returning ascending this route. EAM-05 is possibly the same site as CA-SBR-491, as they are only 91m apart. The most interesting point about EAM-05 is that once back up on Burnt Flats, the ridge line leads directly to the site. The entire grouping of sites in the Burnt Flats area is easily accessible from Deep Creek when this ridge line is used. In addition, use of the ridge line resulted in 0.69 miles less to return to the starting point.





Figure 11. Lower Kinley investigation.

The physiological data for Lower Kinley ranks as the most efficient when numbers are taken at face value. The CBPM is 455.6 (when combined with Upper Kinley), the lowest of any of the proposed routes, assuming that the PCT was not a proposed route. This number is only low due to the presence of the ridge line; if I had returned up the creek bottom the number would have been much higher. Another interesting factor presented by this ridge line is the amount

of time saved. This is the only investigation where this time saving occurred; it was due to the ridge line and the ease of travel across Burnt Flats.

The archaeological data for this route is not abundant (Table 6 and Figure 12). The Upper portion of the route shares the same Settlement site (CA- SBR-492) as the Burnt Flats West route. The Lower portion of the route only has one previously recorded site, CA-SBR-457. This site is reported to contain a mano, debitage, and blackened soil (Reeder and White 1969); none of these constituents were observed when the site was crossed. There is a site at the bottom of the route, CA-SBR-481, which is considered a Settlement site, with fire affected rock features, debitage, and bedrock mills located adjacent to a stream (McCarthy *et al.* 2000). This site is likely to be more closely related to Deep Creek than Lower Kinley. No settlement type sites exist along the Lower portion of this route, only at the Upper section and at the confluence with Deep Creek at the bottom.

Table 6. Sites located along Upper and Lower Kinley.

<b>Sites</b>	<b>Landform</b>	<b>Bedrock Milling</b>	<b>Midden deposits</b>	<b>Diversity of Lithics</b>	<b>Other Settlement Features</b>	<b>Settlement/ Satellite</b>
SBR-457	Stream Terrace	No	Yes	No	No	Satellite
SBR-468	Stream Terrace	Yes	No	Yes	No	Satellite
SBR-481	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
SBR-492	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
EAM-01	Stream Terrace	No	Yes	Yes	No	Unclear



Figure 12. Settlement sites along Kinley Creek.

### Burnt Flats West

The Burnt Flats West route began at the southern extent of the Burnt Flats area at the divergence of Kinley creek and the un-named drainage (Figure 13). The initial investigation began by traveling across Burnt Flats in order to find a suitable area from which to descend into the drainage. Once an appropriate ridgeline was found, I descended into the drainage and at the very bottom of this ridgeline discovered EAM-07. EAM-07 is likely the same site as CA-SBR-921 but the current site boundary is too small. This area has extensive midden deposits



(over an approximate 100m x 70m area), many bedrock milling features, and large quantities of debitage of many raw materials. EAM-06 was discovered farther downstream, a much smaller site where only midden and a few pieces of debitage were observed. CA-SBR-444 is a site further downstream which was not accessible due to dense vegetation. This dense vegetation resulted in the creek bottom not being traversable and I was forced to climb the hillside on the east/north side of the canyon. After attempting to get as far as possible down the creek, I decided to stop short of the confluence with Deep Creek because of safety reasons.

The CBPM descending the Burnt Flats West route was 428.2 and 614.9 ascending. The route is extremely difficult on the north end near the confluence with Deep Creek and heavily overgrown. Coming back up I intended to stay in the drainage for the duration, but dense vegetation caused me to climb up the west side of the canyon to Highway 173. After passing the dense areas, I dropped back into the canyon for the remainder of the investigation.

The investigation of Burnt Flats West resulted in the two highest maximum heart rates (190bpm) and was extremely difficult. The archaeological evidence for use of this route is strong; however, it should be noted that California State Highway 173 ascends the western wall of this canyon and is the direct route discussed by previous researchers (Altschul *et al.* 1985: 28; Harrington Serrano notes, ca. 1918 appendix: 159-163). The creek bottom is very difficult to travel

and if a trail was present in the current position of highway 173 it would be a much easier journey.



Figure 13. Burnt Flats West investigation.

Burnt Flats West is a route with high costs in energetic requirements. The CBPM ascending this route is 614.9, but when combined with the Upper Kinley section, the CBPM is reduced to 502.1. The journey up presented challenges

that increased the energetic requirement beyond what would have been required if I was able to stay in the canyon. In two cases I was forced to climb out of the drainage and up steep canyon walls to bypass dense vegetation (Figures 14 and 15). The total calories burned are 1814, but the distance is only 2.95 miles, resulting in the high CBPM number. When viewed in combination with Upper Kinley, the CBPM of 502.1 is more representative of the energetic requirements of the route.



Figure 14. Navigational error resulting in increased calorie expenditure on Burnt Flats West.



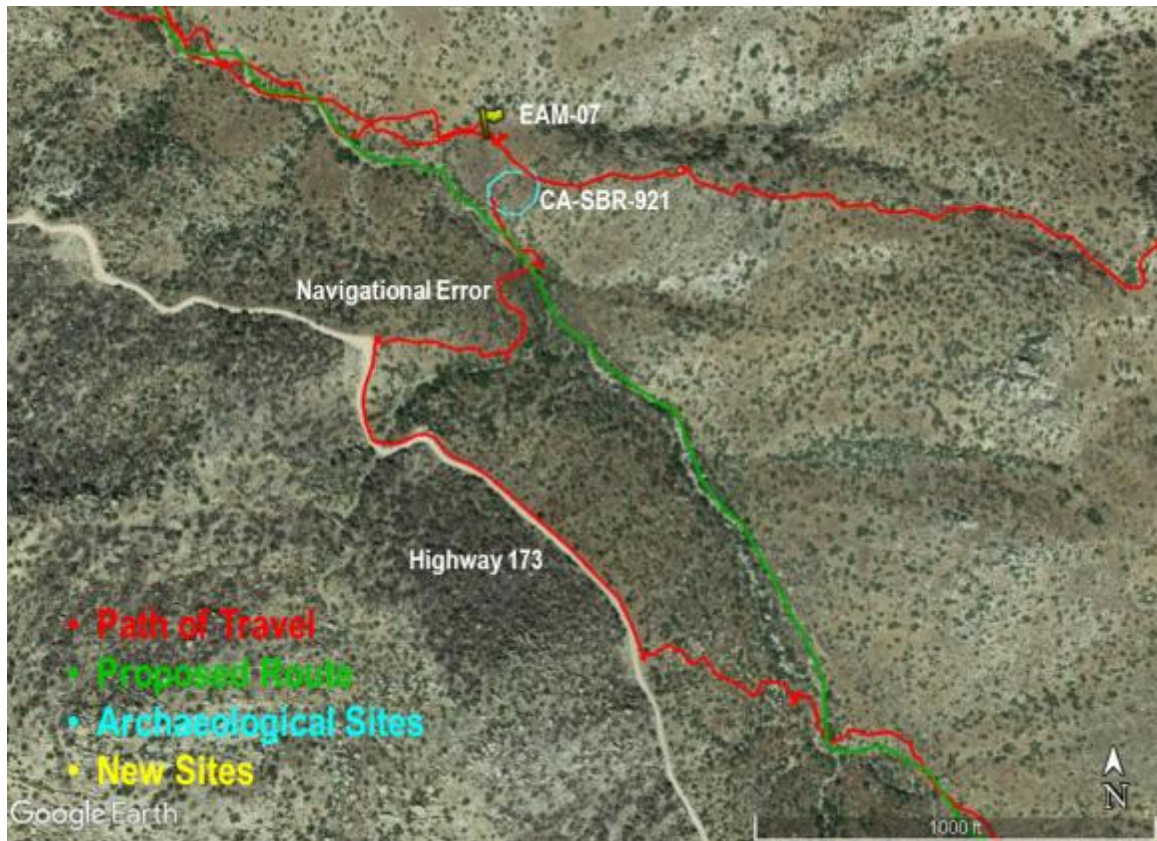


Figure 15. Second navigational error resulting in increased calorie expenditure on Burnt Flats West.

The archaeological evidence for use of the Burnt Flats West route is the most robust of any of the proposed routes (Table 7). There are two sites along this route that meet the criteria for Settlement sites. CA-SBR-921 is a large site located on a stream terrace with extensive midden deposits, bedrock mills, and a variety of lithic material types. EAM-07 is near CA-SBR-921 and appears to be the same site, necessitating an update to the current boundary. On the Upper Kinley portion of this route is CA-SBR-492, another Settlement site with all the

same characteristics as CA-SBR-921. EAM-01 is also located near CA-SBR-492 (85m) and they are likely associated. On the lower portion (Burnt Flats West) there are two more archaeological sites, EAM-06 and CA-SBR-444. I walked quickly across EAM-06 and it is unclear if it could be classified as a Settlement site. CA-SBR-444 has reported midden and a single bedrock milling feature (Reeder and White 1968). This site was not accessed during the investigation due to dense vegetation, and it is unclear if it is a Settlement site or not. CA-SBR-938 is located at the bottom of this route at the Deep Creek confluence. CA-SBR-938 is adjacent to a creek and meets the requirements for a Settlement site, with circular house pits, projectile points, pottery, shell beads, manos, metates, and bedrock mortars (Smith 1963; Reynolds 1977). The archeological evidence of use of this route is the strongest for any of the proposed routes (Figure 16).

Table 7. Sites along Burnt Flats West route.

<b>Sites</b>	<b>Landform</b>	<b>Bedrock Milling</b>	<b>Midden deposits</b>	<b>Diversity of Lithics</b>	<b>Other Settlement Features</b>	<b>Settlement/Satellite</b>
SBR-921/Eam-07	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
SBR-444	Stream Terrace	Yes	Yes	Yes	No	Unclear
SBR-938	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
SBR-468	Stream Terrace	Yes	No	Yes	No	Satellite
EAM-01	Stream Terrace	No	No	Yes	No	Unclear
EAM-06	Stream Terrace	No	Yes	No	No	Unclear



Figure 16. Settlement sites along Burnt Flats West.

### Grass Valley Creek

Grass Valley Creek is the most westerly route of the investigation and the deepest incised drainage within the project area other than Deep Creek. This investigation was the only one to proceed from Rock Camp all the way down to Summit Valley and back up in one day (Figure 17). The CBPM was the second highest (676.8) while ascending of all the investigations. The CBPM was 418.3 while descending. One new archaeological site was found: EAM-09 is a bedrock milling feature roughly half way along the route between the Summit Valley and

Rock Camp. There are likely many more archaeological constituents in the vicinity of EAM-09, but recent (winter of 2016 – 2017) alluvial deposits were observed over 40cm in depth in a drainage coming down the northern wall of the canyon. This recent alluvial deposition was a result of winter precipitation causing extensive erosion on the slopes of the canyon as a consequence of the Pilot Fire (August 8 -16 2016).

Traversing this route was extremely difficult on the ascent, with many large boulders to climb over. The total calories burned on the journey up was 2951, 716 more than the second highest route (PCT Up). The journey down burned 1786 calories, 318 more than the second highest route (PCT Down). The ascending route also resulted in the highest average heart rate at 169bpm. Indeed, I almost collapsed from exhaustion in the last mile of the journey. For context, the average calories burned while running a marathon are approximately 2792 for males and 2436 for females (Loftin *et al.* 2007: 1190). This journey is more intensive, in terms of calories, than running a marathon, if done in a single day.

The archaeological evidence for use of this route is very poor, with only one archaeological site along its length. EAM-09 is a lone bedrock milling feature directly adjacent to the creek; no other cultural material was observed. The steep canyon walls of this route deposit large amounts of alluvium and colluvium along the banks of the creek. This might be obscuring the archaeological visibility of sites along the creek; however, interpretations cannot be provided because of a



lack of evidence. The top of the route leads directly to Rock Camp, arriving from the west. The bottom of the route leads directly to CA-SBR-303, -1676, -4189, -4916, and -6175. There are no previously recorded sites along the length of the route and EAM-09 cannot be considered a settlement site due to a lack of diagnostic characteristics. Much like Pinnacles South, Grass Valley Creek has little archaeological evidence to indicate use as a primary travel corridor during prehistory.



Figure 17. Grass Valley Creek investigation.



### Pacific Crest Trail/Deep Creek

The section of the PCT investigated began near Splinters Cabin 4.65 miles east of Rock Camp (Figure 18). This area was chosen for two reasons, ease of driving access to the starting point and its location outside the spatial boundaries of the proposed model. The survey was the only one where “on-trail” (unimpeded travel) travel was possible for the entirety of the survey. The survey was the longest of all the field investigations (5.5 miles) and boasted the lowest CBPM while going descending in elevation (266.9). The survey discovered one new archaeological site (EAM-08) and passed by five previously recorded sites along the creek. The CBPM ascending in elevation was 411.6. This is the third most efficient route but will likely be the most efficient when put into context (see discussion below). The most revealing statistics from the PCT investigation are the time and pace relative to the calories burned, a result of the well-used trail for travel.

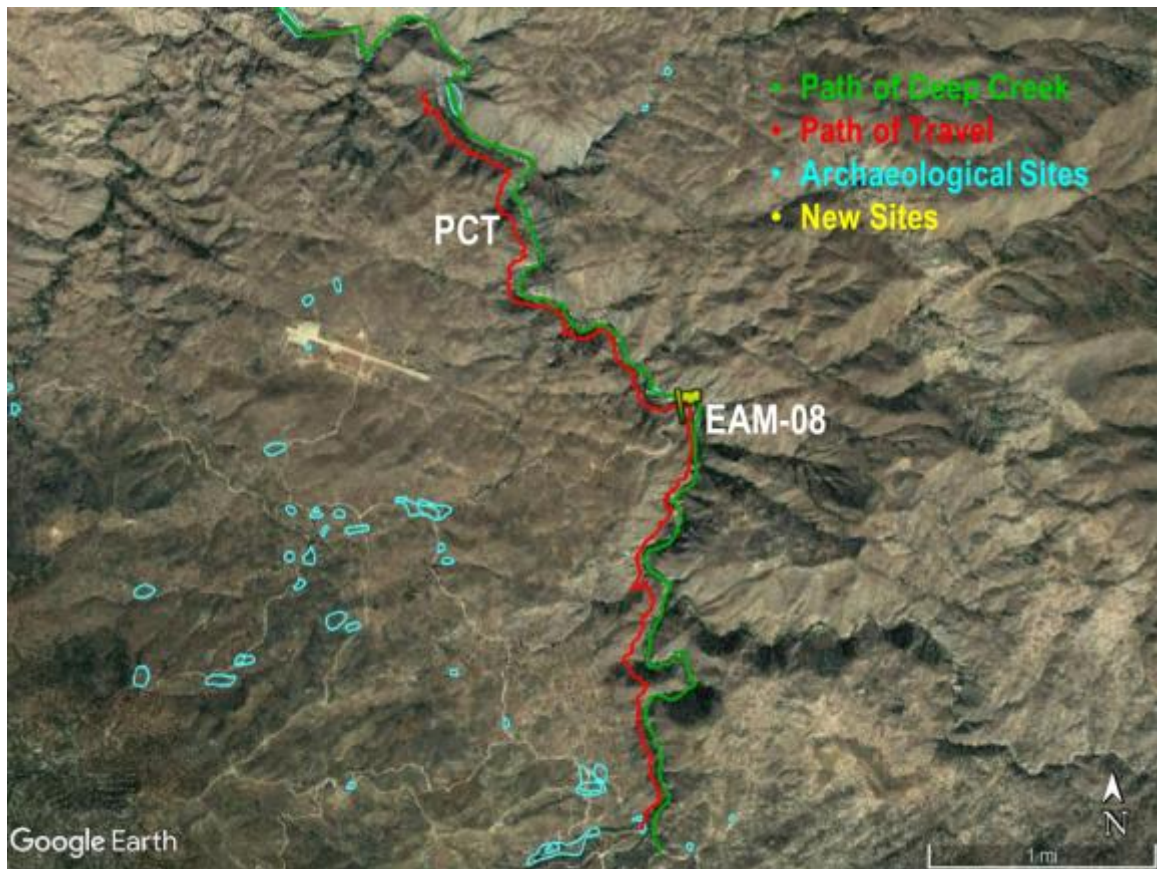


Figure 18. Pacific Crest Trail/Deep Creek investigation.

The physiological data are very convincing for assessing the efficiency of traveling on trails. The PCT/Deep Creek route was the longest in distance of any of the investigations at 5.5 miles; the elevation gain was the largest at 2029'; total calories burned were the second highest at 2235; and the pace was the fastest while ascending at 2.2mph. With all these high numbers relative to the rest of the data, the most informative measure is CBPM at 411.6. This factor demonstrates the efficiency of traveling on trails and the inefficiency of off trail travel. When

placed in the correct context, the PCT is the most efficient of all the routes investigated. There are lower CBPM numbers within the data set, Upper Kinley (ascending and descending) and Upper Pinnacles (ascending and descending), but both these routes are much shorter in distance and require substantially less elevation gains. They should also be viewed in combination with adjoining routes (Lower Kinley, Burnt Flats West and Lower Pinnacles). The most efficient route while descending was the PCT/Deep Creek with a CBPM of 266.9. This route provided the most efficient means of travel of any of the routes investigated.

The archaeological evidence for the PCT/Deep Creek route is the most convincing in the area. This is not surprising, considering Deep Creek is the primary source of water feeding the Mojave River. The quantity of archaeological sites along Deep Creek from Summit Valley up to Splinters Cabin is substantial, with 16 previously recorded sites and one new archaeological site (EAM-08). Eight of these sites; CA-SBR-294/H, -295, -452, -472, -477, -478, -479, and, -938 (Table 8 and Figure 19), all display the characteristics of Settlement sites, viz. diversity of lithic materials, bedrock mills, midden deposits, and locations on stream terraces (Reeder and White 1968; Scrivner and Benton 2000; Reynolds 1977; Scrivner 2014).

Table 8. Settlement sites along Pacific Crest Trail/Deep Creek.

<b>Sites</b>	<b>Landform</b>	<b>Bedrock Milling</b>	<b>Midden deposits</b>	<b>Diversity of Lithics</b>	<b>Other Settlement Features</b>	<b>Settlement/ Satellite</b>
SBR-938	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
SBR-473	Stream Terrace	No info	No info	No info	No info	Unclear
SBR-458	Stream Terrace	No info	No info	No info	No info	Unclear
SBR-10000/H	Stream Terrace	Yes	No	Yes	No	Unclear
SBR-481	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
SBR-483	Stream Terrace	No info	No info	No info	No info	Unclear
SBR-294/H	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
SBR-472	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
SBR-295	Stream Terrace	No	Yes	Yes	Yes	Settlement
SBR-479	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
SBR-478	Stream Terrace	Yes	Yes	Yes	No	Unclear
SBR-477	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
SBR-453	Stream Terrace	No	No	Yes	No	Satellite
SBR-452	Stream Terrace	No	No	Yes	No	Satellite
SBR-5773	Stream Terrace	Yes	Yes	Yes	Yes	Settlement
EAM-08	Stream Terrace	No	Yes	No	No	Unclear

Although the PCT/Deep Creek route is not proposed in the model, it boasts the most efficient means of travel for any of the routes investigated (Tables 2 and 3) when all data are viewed in context. The archaeological

evidence is also the most abundant, with eight Settlement sites and nine Satellite sites existing along the route.

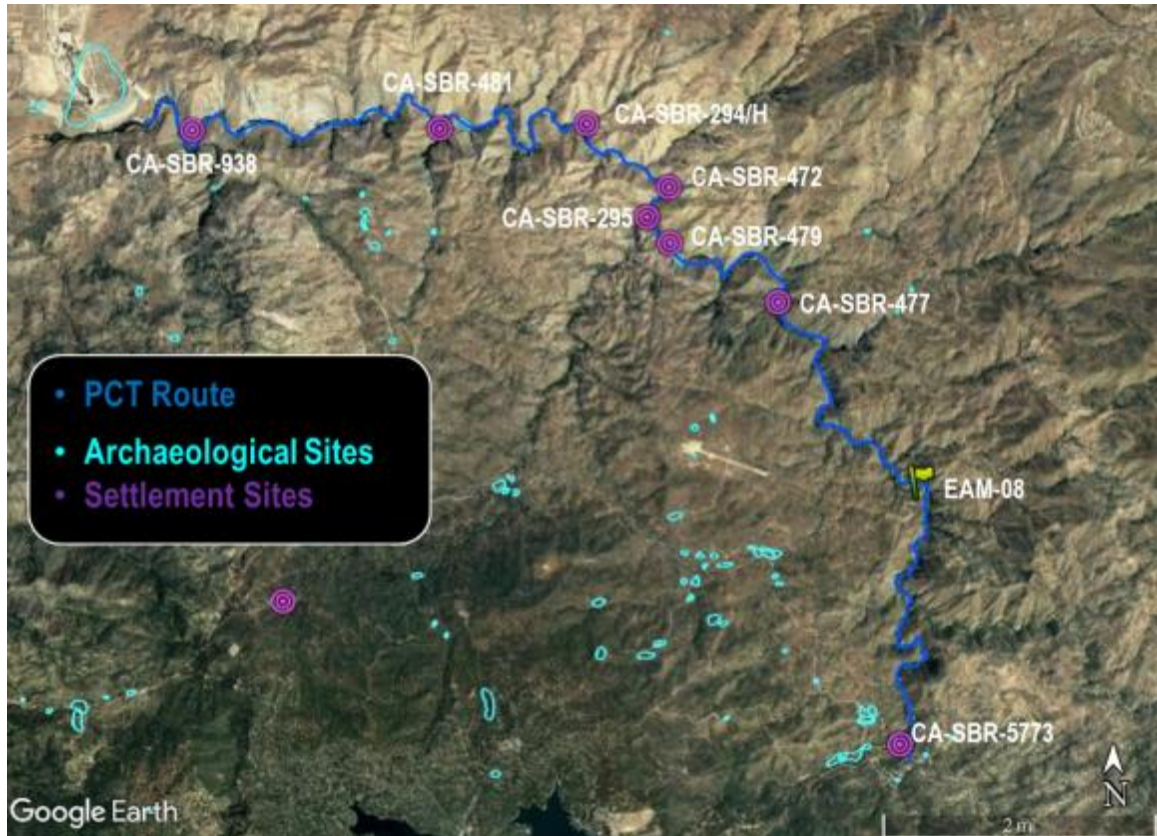


Figure 19. Settlement sites along Pacific Crest Trail/Deep Creek.

### Exploratory

The final route was one that is not represented in the Altschul *et al.* model. This route was investigated in a spontaneous fashion when the goal of the day was to investigate Upper Kinley (Figure 20) but chose to explore this route out of

curiosity. There are three previously recorded archaeological sites (CA-SBR-494, 495, and P1323-01) if one follows this drainage system up to its highest elevations. I was not able to reach the elevations where these sites are located due to difficult terrain. The route resulted in the highest CBPM (773.9) as well as the highest CBPM (586.5) while descending. The route did yield a new archaeological site (EAM-02), but this site was beyond the mouth of the canyon where travel was much easier. The route consisted mostly of boulders and very steep slopes and is not a viable route of travel. The area would be much more suited for foraging or hunting rather than traveling.





Figure 20. Exploratory investigation.

## CHAPTER SIX

### DISCUSSION AND CONCLUSIONS

The structure of this discussion will be as follows, exertion considerations as they relate to the data gathered, how those data assist to answer the research questions, conclusions related to the research questions, analysis of the settlement model, and finally, directions of future research. The exertion discussion will focus on flaws in the methodological choices, mobility observations gained during field investigations, and how errors in the field may skew the data. The conclusions will focus on the physiological and archaeological data to answer the research questions. The settlement model discussion will focus on plants and geospatial distributions of archaeological sites. The future research discussion will focus on the needs of future studies specifically related to the region and how one might target specific sites for specific archaeological data.

#### Energetic Considerations

After completion of the fieldwork for this thesis, there were several flaws identified in the methods. If future mobility studies similar to this are to be successful, these methodological flaws must be acknowledged. The first major issue was the choice to follow drainages, particularly drainage bottoms. The



hand drawn map of the settlement system (Figure 5; Altschul *et al.* 1985: 72) provided rough estimations of path locations based on geographic drainages. However, it became quickly apparent that travel within drainage bottoms is very difficult in comparison to walking on a trail or ridge line. The methodological choice to not carry a map and only use field of vision to make directional determinations resulted in navigational decisions both positive and negative in regards to data gathered.

One negative result from the lack of a map is that on two routes, Lower Kinley and Burnt Flats West, I was forced to climb out of the drainages. Climbing out of the drainages resulted in more calories burned. In the case of Burnt Flats West, I had to climb out of the drainage twice on the ascent (Figure 14 and 15). This elevated the calorie data significantly, and this is unfortunate because this route boasts the most archaeological evidence for use in prehistory. The density of vegetation in the drainage bottom may have altered the physiological data; however, this might also be an indication of rich resource patches on this route and why there are Settlement sites along it.

One of the positive results of this methodological error was the discovery of the efficiency of walking ridge lines in the Burnt Flats area. After reaching an unpassable cliff/waterfall while traveling down Lower Kinley, I eventually found a ridge line that led directly down to Deep Creek from Burnt Flats (Figure 11). The efficiency of walking up the ridge line drastically changed the calories and time related to the Lower Kinley route. This factor in turn skewed the calorie data

toward lower energetic requirements, providing lower numbers in relation to the archaeological evidence. However, regardless of the calorie data, the discovery of ridge lines and the Burnt Flats landform provided interpretive insight to the importance of the landform and why there are at least five archaeological sites on it. Burnt Flats is one of the most gentle and easily traveled landforms in the region; one can get from the waters of Deep Creek up to higher elevation in a very short period of time (40-50 minutes at a pace between 1 and 2 mph). The position of Burnt Flats and the inviting nature of the landform caused me to travel upon it for extended periods, far outside the proposed routes (Figure 21). Knowing the landform was there and easy to travel upon, resulted in two instances where the landscape altered my intentions in relation to the objective.

The other major issue with the methodology was the decision to walk these routes both ascending and descending (or descending and ascending) in the same day. This factor caused me to have a heightened sense of the energy required to travel these routes. By the time I had stopped to start coming back up or down, I had already spent considerable amounts of energy, and this would have been highly unlikely in a prehistoric context. From a logistical perspective, it would have been more beneficial to have doubled the time of field investigations, and only walked in one direction on any of the routes on a given day. This would have been more complicated logistically, but would have provided longer distances traveled and more physiological data to use in answering the research questions.

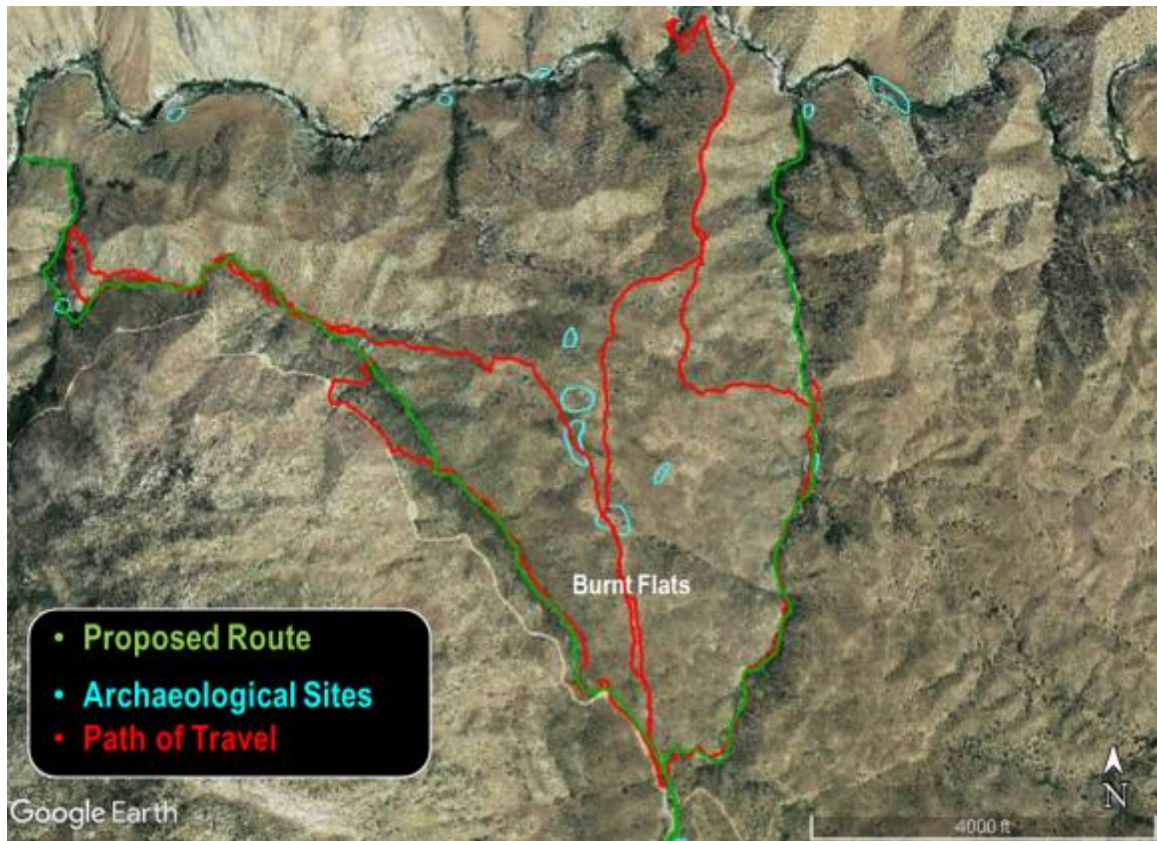


Figure 21. Burnt Flats paths of travel.

Of the routes proposed by Altschul *et al.*; Burnt Flats West to Upper Kinley, Lower Kinley to Upper Kinley, Pinnacles South, and Grass Valley Creek, two stand out in the data as the most efficient. Lower Kinley to Upper Kinley ranks as the most efficient with a combined CBPM of 455.6. The archaeological evidence for use of this route is the presence of at least two Settlement sites along its path (Table 6 and Figure 12). The archaeological evidence is not the strongest, and with the benefits of the ridge line from Deep Creek up to Burnt

Flats, the calorie data was skewed lower than reality, this is possibly an indication of alternative travel paths in prehistory. It is also possible that the site at the bottom (CA-SBR-481) is associated with the Deep Creek/PCT route. If CA-SBR- 481 is associated with the Deep Creel/PCT route, Lower to Upper Kinley would only have one Settlement site along it.

The second most efficient proposed route in terms of the physiological data is the Pinnacles South route. The combination of upper and lower CBPM numbers is 497.6, a difference of 4.5 from the next most efficient route. This route was not completed (Figure 9) and the CBPM would have been higher if the route was completed. The archaeological evidence on this route is poor with only two sites observed (EAM03 and EAM-04), neither of which has enough information to be designated as a Settlement. The evidence for use of this route in prehistory as a frequent travel corridor is inconclusive at this point.

The third most efficient route is Burnt Flats West to Upper Kinley with a combined CBPM of 502.1. Complications with this route have been discussed in Chapters 5 and 6, these complications skewed the calorie data higher than required. The archaeological evidence for use of this route is the strongest of any proposed, with two definite Settlement sites, CA-SBR-921 and -492, along its path (Table 7 and Figure 16) in addition to those at the top and bottom. Considering the skewed calorie data and the strong archaeological evidence, it is likely that this route was used most frequently in prehistory. These factors, in combination with the ethnographic mention of this route (Altschul *et al.* 1985: 28;

Harrington Serrano notes, ca. 1918. appendix: 159-163), provide a rational for speculating that a trail once followed a path somewhere near the current California State Highway 173 (Figure 22).

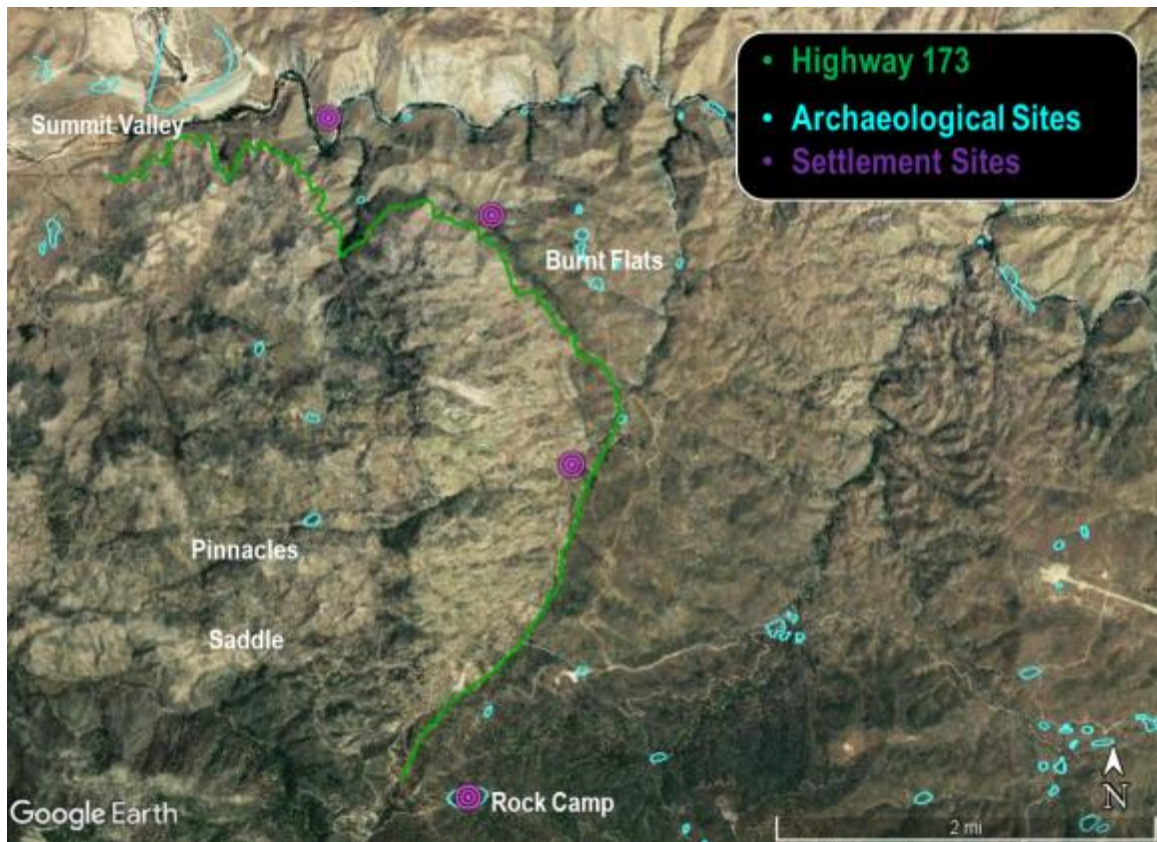


Figure 22. Path of Highway 173.

The route that has the most archaeological evidence of use is the Pacific Crest Trail or Deep Creek route. The route has eight Settlement sites along its

path (CA-SBR-294/H, -295, -452, -472, -477, -478, -479, and, -938), six more than Burnt Flats West to Upper Kinley (Table 8 and Figure 19). The physiological data also support this conclusion, with the lowest CBPM (411.6), the fastest pace (while ascending 2.2 mph), the most elevation gained and lost (2029' and 1988'), and the longest distances traveled (5.5miles). This combination of factors provides two alternative sets of data that support an interpretation that this route was the most frequently used in this region in prehistory. This route is not within the spatial boundaries of the Altschul *et al.* model.

The fact that the most efficient route is not within the spatial boundaries of the proposed settlement model requires explanation. It is likely related to the spatial restrictions placed on the original project commissioned by the U.S. Army Corp of Engineers, although the fact that the most efficient route does not lead to the settlement of Rock Camp cannot be ignored. Perhaps some of the sites outside the spatial boundaries of the proposed settlement model (Willow Creek Crossing, Stove Flats, Saddle Flats, and Splinters Cabin) should be investigated with these new data in mind (Figure 22).

## Conclusions

The conclusions for this investigation will be presented in relation to the two research questions.

**1. Which of the Altschul et al. travel routes is the most efficient in terms of energetic/caloric output?**

After analysis of the data I conclude that the Lower Kinley to Upper Kinley is the most energetically efficient. However, this route does not possess the most archaeological sites. Burnt Flats West to Upper Kinley exhibits the most archaeological evidence. With the navigational errors encountered on Burnt Flats West, it is my contention that this route was probably the route used most frequently in prehistory. If one were to travel the current path of Highway 173 from Summit Valley up to Rock Camp (Figure 22) energy efficiency would likely be similar to the results of the PCT/Deep Creek data (CBPM 411.6).

**2. Of all the routes investigated which one has the most archaeological evidence for use? And is that route within the spatial boundaries of the current model?**

After analysis of the data, the PCT/Deep Creek route exhibits the most archaeological evidence. There are eight archaeological Settlement sites along its path. This route is outside the spatial boundaries of the Altschul et al. model. This route is also the most energetically efficient, with the lowest CBPM of 411.6. This route follows the most substantial waterway in the region and is a major travel corridor in modern times.

The efficiency principles of HBE and OFT are substantiated by the conclusion to the second research question(s). The results of the investigations within the spatial boundaries of Altschul et al.'s model are not consistent with the

theoretical principles of efficiency, but this is a result of errors in the field methodology. We can speculate that if methods were refined and paths allowed unimpeded travel that the most efficient route would likely display the most archaeological evidence.

### Settlement Model and Analysis

When this model was first proposed in the Altschul *et al.* 1985 report, the primary factors in the development of the model were plant food distributions and known archaeological sites. With an established ethnographic account of the seasonal movements of the Serrano, model construction is straight forward. All that was needed was the connection of the winter settlements with the higher elevation settlement sites by following streams. The simplicity of this connection breaks down when the factors driving movement are examined.

The importance of plant distributions across the mountain slopes as a determinant of travel routes is very difficult to either prove or disprove when attempting to project current plant communities into the past. Throughout the Holocene, plant communities have been migrating in elevation with changing climate (Moratto, King and Woolfenden 1978; LaMarche Jr 1973; Wells and Jorgensen 1964). For this research area, the most important plant resources to focus on are single leaf pinyon and California black oak. While many of the sites reported in Reeder and White (1970) specify a pinyon juniper landscape, one



would have a difficult time characterizing the current landscape as such.

Currently most of the landscape would be characterized as mountain chaparral at elevations lower than the oak and mixed conifer woodlands because very few pinyon and juniper trees grow here. The drastic change in plant communities in such a short period of time is due to the frequency of wildfires in the San Bernardino Mountains. After significant fire episodes the vegetation can take 100-150 years to return to mature woodland conditions (Wangel and Minnich 1996: 493). Given the frequency of wildfires in the last decade it would appear the range is currently in an intermediate period where the pinyon-juniper woodland has not yet rejuvenated.

The current elevation range of the oak and mixed conifer woodland (3500'-6500') fits well with the location of settlement sites such as Rock Camp. The transition between mountain chaparral and oak and mixed conifer woodland is currently the only change in plant communities that exists within area of the settlement model. Therefore, assigning specific targeted plant resources to settlement sites along the travel routes would require specific paleo-ethnobotanical data gathered during excavations. When the pinyon-juniper woodlands were strong and healthy, many of the sites along the routes would have likely been linked to the harvesting of pinyon. The elevation range of pinyon-juniper woodlands is much more varied (3000' - 9000') and these elevations are within the same ranges as the current model.

The final issue with plant communities and how they are likely to dictate movement relates to ripening and blooming cycles. The Altschul *et al.* model relies heavily on the notion of plant ripening and blooming cycles driving the movements of people to successively higher elevations throughout the changing seasons. This idea of ripening and blooming cycles causing populations to move successively higher in elevation as the seasons progressed is an assumption. There are no references provided in the Altschul *et al.* report for this statement, and no supporting evidence of this has been found during the research for this thesis. This is not to say that this ecological factor is not accurate, but rather to point out that these assumptions present a clean and simple rationale for projecting human movements to higher elevations that is in fact unwarranted. The variations in these ripening and blooming cycles are likely to fluctuate from year to year and the movements were likely flexible as well.

The distribution of archaeological sites in the research area presents a large sample of sites for analysis. The most relevant site type for this discussion is that of Settlements and their locations. All sites identified as Settlements are located along stream terraces (Figure 23). This is not surprising considering the importance of water. However, many other sites exist in the research area outside of the spatial boundaries of the current model. Thus, the sites along the routes leading to Rock Camp represent only a small proportion of the archaeological sites in the research area. Therefore, identification of similar

areas within the region where sites comparable to Rock Camp are likely located is required.

The first of these areas is the complex of sites at the Willow Creek crossing (CA- SBR-296, -1616, -2666, and -10004), downstream from Rock Camp within oak and mixed-conifer woodland. This complex of sites is similar to the assemblage at Rock Camp (Allen 2016). Moving east from Willow Creek are numerous sites located south of Squints Ranch in the Stove Flats area (Figure 24). West from Rock Camp there are a group of sites located within the current oak and mixed-conifer woodlands. These sites (CA-SBR-916, -4289, -4290, and -4291) are located south of the Saddle Flats and Mount Mary Louise (Figure 24). Both these areas are within the oak and mixed conifer woodlands and they already have archaeological sites identified there.

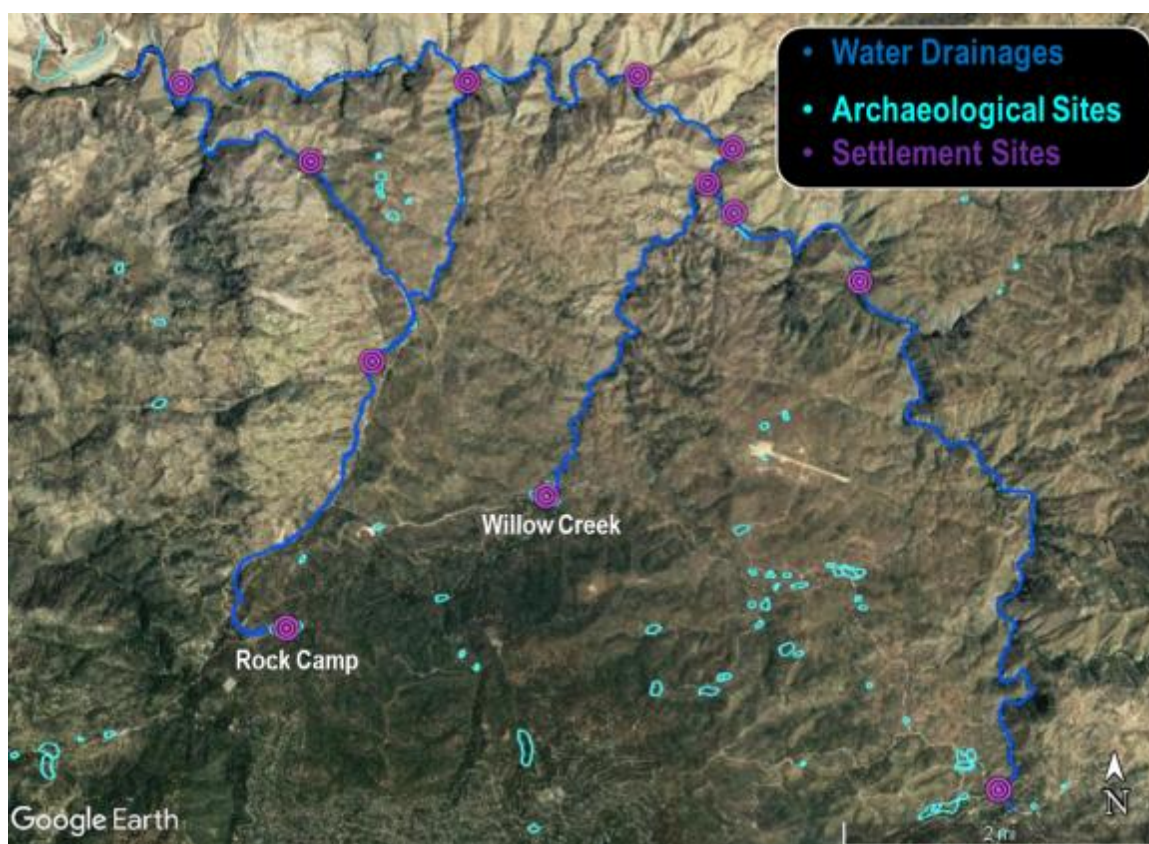


Figure 23. Settlement sites and water drainages.

The presence of many archaeological sites in the region is a clear indication that there was much more settlement system activity happening beyond the system around Rock Camp. Thus, more settlement sites need to be located and added to the existing information. The mobility pattern follows water and is linked to the elevation range of oak and mixed-conifer woodland. Expansion of the model in other areas of the range should seek to be guided by these factors if the goal is to define the settlement and subsistence practices of the Serrano in the San Bernardino Mountains in more detail.



Figure 24. Areas of potential settlements.

#### Directions for Future Research

The San Bernardino Mountains have been under-researched in California archaeology (Jones and Klar 2007; Moratto 2004). Nevertheless, the research reported here would not have been possible without some previous work to provide context and direction. Without Cultural Resources Management and

Forest Service projects there would be almost no formal research for the range. Current academic research projects by Dr. Mark Allen (Cal Poly Pomona) and graduate students at California State University, San Bernardino are a great start to expanding our knowledge of the archaeology of these mountains. The results of this investigation have provided more clarity to the settlement pattern for a small portion of the entire range. Future research projects should seek to expand on previous investigations in three research areas; chronology, expansion of the settlement model, and furthering the explication of site types.

The settlement model investigated during this project is specifically related to the Late Prehistoric period (A.D. 200 – contact/Protohistoric). The settlement pattern in this portion of the range has roots deep in antiquity, with obsidian hydration dates as early as 5000 B.C at Rock Camp and the collection of sites at the Willow Creek crossing (Allen 2016). Farther east in the range, around the current city of Big Bear and the Baldwin lake area, Early Holocene (8000 – 6000 cal B.C) sites have been reported based on projectile point types (Denardo and Texier 2011: 83). Nevertheless, the chronology of settlement in the range is not well defined; future research should seek to clarify the chronology for the region. Focused excavations at settlement sites could provide the data to establish chronological frameworks. Obsidian hydration and/or AMS radiocarbon dates from the lowest levels of deposits at settlement sites should be a priority.

The issue of chronology could also illuminate new research questions as they relate to subsistence strategies. The settlement pattern in the San

Bernardino Mountains is linked to the importance of the fall harvest of acorns in areas like Rock Camp. Establishing a chronology for the pattern of sites would help to clarify if the pattern is more related to topography or staple resources. The presence of early dates at Rock camp (Allen 2016) would indicate the pattern was in use prior to the subsistence shift toward acorn intensification or related to alternative plant foods present during past climate regimes.

Reeder and White (1970) provided an interpretation of landform correlation to chronology. Their ideas are difficult to test because the quality of the site records is inadequate. However, the collections from their work (at the San Bernardino County Museum) could contain artifacts (e.g. projectile points) suitable for relative dating to aid in future analyses. Pertinent questions would be related to whether the hypothesized pattern of landform correlating with chronology is real. If it is, do the earlier occupations, “ridge” and “meadow” (Reeder and White 1970: 4), follow a similar or different spatial pattern from the established Late Prehistoric pattern? The establishment of a firm chronological framework should be the primary goal of any future research project in the area. Many other archaeological research issues related to materialism, social dynamics, etc. are chronologically constrained to the Late Prehistoric, just as this investigation was.

Expansion of the settlement model should begin with investigations of areas within the oak and mixed-conifer woodland, ideally in areas with nearby water insufficient quantity to sustain populations. Ethnographic place names and

geographic landmarks will aid in the demarcation of routes used to access higher elevations. Above all else, expansion of the model should seek to obtain more complete quantitative data in relation to the archaeological site constituents. The lack of quality site records was a detriment to this thesis. More data and archival research of past site documentation will help to define site types.



## REFERENCES CITED

- Allen, Mark W.  
2016 New Perspectives on the Rock Camp Site in the San Bernardino Mountains: the Cal Poly Pomona Willow Creek Archaeological Research Project. Paper presented at the 50th annual meeting of the Society for California Archaeology, Ontario, California.
- Allen, Mark W., and Arlett J. Carmona  
2016 Getting to the Points of Rock Camp: Chronology and Connections. Paper presented at the 50th annual meeting of the Society for California Archaeology, Ontario, California.
- Altschul, Jeffery  
1991 The Deep Creek Site Revisited. On file at the San Bernardino National Forest Service Supervisors Office.
- Altschul, Jeffrey H., Martin R. Rose, Michael K. Lerch  
1985 Cultural Resources Investigations in the Mojave River Forks Reservoir, San Bernardino County, California. On file at the San Bernardino National Forest Service Supervisors Office.
- Basgall, Mark E. and Delbert L. True  
1985 Archaeological Investigations in Crowder Canyon, 1973-1984: Excavations at Sites SBR-421B, SBR-421C, SBR-421D, and SBR-713. Volume I. On file Applied Earthworks Hemet Office.
- Bean, Lowell J. and Charles R. Smith  
1978 *Serrano. Handbook of North American Indians*. Volume 8, 570-574.
- Benedict, Ruth Fulton  
1924 A Brief Sketch of Serrano Culture. *American Anthropologist*, New Series, 26 (3):366-392.
- Bettinger, Robert. L.  
2001 "Holocene hunter-gatherers." In *Archaeology at the Millennium*. pp.137-195. Springer USS.  
1991 Hunter-gatherers. *Archaeological and Evolutionary Theory*. Springer USS.  
1976 The Development of Pinyon Exploitation in Central Eastern California. *The Journal of California Anthropology*, 3(1): 81-95.

- Bettinger, Robert. L. and Martin Baumhoff A.  
 1982 The Numic Spread: Great Basin Cultures in Competition. *American Antiquity*, 47(3): 485-503.
- Binford, Lewis R.  
 1980 Willow Smoke and Dogs' Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1): 4-20.
- Denardo Carole, Bruno Texier  
 2011 FINAL Report: An Archaeological Inventory for the Baldwin Healthy Forest Project, San Bernardino National Forest, California. On file at the San Bernardino National Forest Service Supervisors Office.
- Douglass, John G., Brian Boggs, Polly A. Peterson, Jill A. Onken, and Michael K. Lerch  
 2009 Archaeological Field School 2005-2006: Results of the 2005-2006 Session. California State University, San Bernardino. San Bernardino National Forest. Statistical Research, Inc. On file at the San Bernardino National Forest Service Supervisors
- Earle, David D.  
 2005 The Mojave River and the Central Mojave Desert: Native Settlement, Travel, and Exchange in the Eighteenth and Nineteenth Centuries. *Journal of California and Great Basin Anthropology*, 1-38.
- Earle, David D., & Nuez, Joaquin P.  
 2010 Fray Joaquín Pascual Nuez's Account of the Mojave River Expedition of 1819. *Journal of California and Great Basin Anthropology*, 184-192.
- Erlandson, Jon M., Torben C. Rick, Terry L. Jones, and Judith F. Porcasi  
 2007 One if by land, two if by sea: who were the first Californians. *California Prehistory: Colonization, Culture, and Complexity*, 53-62.
- Fagan, Brian. M.  
 2004 *Before California: An archaeologist looks at our earliest inhabitants*. Rowman Altamira.
- Harrington, John Peabody  
 1918 Ethnographic field notes on the Cahuilla, Luiseño, and Serrano, on

file at the National Anthropological Archives, Smithsonian Institution, Washington, D.C. Copies in CSRI files.

Hedges, Ken

- 1977 Review: Rock Camp Site: Archaeological Excavation of an Indian Campsite Near Lake Arrowhead, San Bernardino Mountains. *The Journal of California Anthropology*, 4(1):138-139.

Herzog, Irmela and Axel Posluschny.

- 2008 Tilt–Slope-Dependent Least Cost Path Calculations Revisited. In *Proceedings of the 36th CAA Conference* (Vol. 2, p. 6).

Hildebrandt, William R. and Allika Ruby

- 2006 Prehistoric Pinyon Exploitation in the Southwestern Great Basin: A View from the Coso Range. *Journal of California and Great Basin Anthropology*, 11-32.

Howey, Meghan C.

- 2011 Multiple Pathways Across Past Landscapes: Circuit Theory as a Complementary Geospatial Method to Least Cost Path for Modeling Past Movement. *Journal of Archaeological Science*, 38(10): 2523-2535.

James, Steven R.

- 2016 Rock Camp Revisited: Implications of the Zooarchaeological Analysis for Understanding Prehistoric Hunting Patterns in the San Bernardino Mountains. Paper presented at the 50th annual meeting of the Society for California Archaeology, Ontario, California.

Johnson, Matthew

- 2010 *Archaeological theory: an introduction*. John Wiley & Sons.

Jones, Terry L. and Kathryn A. Klar (Eds.).

- 2007 *California Prehistory: Colonization, culture, and complexity*. Rowman Altamira.

Kelly, Robert. L.

- 1995 The Foraging Spectrum, Diversity in Hunter-Gatherer Lifeways. *Washington*: Smithsonian Institution Press.  
1992 Mobility/Sedentism: Concepts, Archaeological Measures, and Effects. *Annual Review of Anthropology*, 21(1): 43-66.

- 1983 Hunter-Gatherer Mobility Strategies. *Journal of anthropological research*, 39(3): 277-306.
- Kirby, Matthew E. Susan Zimmerman R., William Patterson P. and Jose Rivera J.  
2012 A 9170-Year Record of Decadal-to-Multi-Centennial Scale Pluvial Episodes from the Coastal Southwest United States: A Role For Atmospheric Rivers? *Quaternary Science Reviews*, 46: 57-65.
- LaMarche, Valmore C.  
1973 Holocene Climatic Variations Inferred from Treeline Fluctuations in the White Mountains, California. *Quaternary Research*, 3(4): 632-660.
- Lanner, Ronald. M.  
1981 *The Piñon Pine: A Natural and Cultural History*. University of Nevada Press.
- Laylander, Don.  
1997 "Inferring Settlement Systems for the Prehistoric Hunter-Gatherers of San Diego County, California." *Journal of California and Great Basin Anthropology*. 179-196.
- Limahelu, Beth, Arlett Carmona, Jane Fernandez. Mariah Flower, Isaac Limahelu, Lauren Macias, and Amanda Smith  
2016 Further from the points: Reanalysis of the Rock Camp Groundstone, Ceramics, and non-utilitarian Artifacts. Paper presented at the 50th annual meeting of the Society for California Archaeology, Ontario, California.
- Loftin, Mark, Melinda Sothern, Cathie Koss, Georgianna Tuuri, Connie VanVrancken, Anthony Kontos, and Marc Bonis  
2007 Energy Expenditure and Influence of Physiologic Factors During Marathon Running. *Journal of Strength and Conditioning Research*, 21(4): 1188.
- Matti, Jonathan C. and Douglas M. Morton  
2000 Geology of the San Bernardino National Forest. U.S. Geological Survey. Unpublished manuscript.
- McCarthy, Daniel, Julie A Scrivner, Melinda Benton  
2000 Archaeological Investigation of the Willow Fire Incident during the Burn Area Emergency Response Treatment. CA-SBR-295,-452, -472, -477, -478, -479,-481 and, -938 site records. On file at the San Bernardino National Forest Supervisors Office.

- McGee, Jon R. and Richard L. Warms.  
2003 *Anthropological Theory: An Introductory History*. Mayfield Publishing Company.
- McKay, Douglas C.  
2005 Report Documenting Archaeological Testing of Prehistoric Sites CA-SBR-00936 and CA-SBR-00488 in the Burnt Flats Area, Section 21, T3n, R3W, Mountaintop Ranger District, San Bernardino National Forest, California. Forest Service Archaeological Reconnaissance Report 05-12-AR-248. On file at the San Bernardino National Forest Supervisors Office.
- Minnich, Richard A.  
2007 Climate, Paleoclimate, and Paleovegetation. *Terrestrial vegetation of California*, 43 -70.
- Moratto, Michael. J.  
2004 *California Archaeology*. Academic Press.
- Moratto, Michael. J., Thomas F. King, and Wallace B. Woolfenden,  
1978 Archaeology and California's Climate. *The Journal of California Anthropology*, 5(2): 147-161.
- Morgan, Christopher.  
2008 Reconstructing Prehistoric Hunter–Gatherer Foraging Radii: A Case Study from California's Southern Sierra Nevada. *Journal of Archaeological Science*, 35(2): 247-258.
- Northwest Economic Associates.  
2004 Ethnographic Overview of the Northern San Bernardino Forest. Part A: The North. On file at the San Bernardino National Forest Service Supervisors Office.
- Nykamp, Robert  
2006 An Archaeological Survey for the Deep Creek/Green Valley Forest Health Project. Mountaintop Ranger District, San Bernardino National Forest, San Bernardino County, California. ARR# 05-12-AR-241. On file at the San Bernardino National Forest Service Supervisors Office.
- Padilla, Lacy Ann  
2017 GROUNDSTONE ANALYSIS AT THE ROCK CAMP SITE.

Pontzer, Herman.

- 2007 Predicting the Energy Cost of Terrestrial Locomotion: A Test of the LiMb Model in Humans and Quadrupeds. *Journal of Experimental Biology*, 210(3): 484-494.

Pontzer, Herman., David A. Raichlen and Michael D. Sockol

- 2009 The Metabolic Cost of Walking in Humans, Chimpanzees, and Early Hominins. *Journal of Human Evolution*, 56(1): 43-54.

Renfrew, Colin, and Paul Bahn

- 2011 *Archaeology: Theories, Methods, and Practice*. New York: Thames and Hudson.

Sawyer, Sarah

- 2017 A summary of current trends and probable future trends in climate and climate-driven processes for the Angeles and San Bernardino National Forests. Forest Service's Pacific Southwest Region Ecology Program.

Scrivner, Julie

- 2014 ARR-0512-SB-023 "The Deep Creek and Coxey Restoration Projects". Unpublished site record for CA-SBR-294/H. On File at the San Bernardino National Forest Supervisors Office.

Smith, Amanda L., Arlett J. Carmona, Lindsay Dean, Adrienne Harwell, Jeanette Maldonado, and Briana Van Patten

- 2016 Besides the Points: Reanalysis of the Rock Camp Site Lithic Assemblage. Paper presented at the 50th annual meeting of the Society for California Archaeology, Ontario, California.

Smith, Gerald

- 1963 CA-SBR-938 site record. Unpublished. Updated by Robert Reynolds (1977).

Smith, Gerald and Mike Moseley

- 1962 Archaeological Investigation of the Mojave River Drainage: *Part I. Quarterly of the San Bernardino Museum Association* 9(3).

Steward, Julian

- 1955 "The Patrilineal Band". *In Anthropological Theory. An Introductory History*. Mayfield Publishing Company (1996).
- Strong, William D.  
 1929 Aboriginal Society in Southern California. University of California Publications in American Archaeology and Ethnology 26(1).
- Sutton, Mark Q., Mark E., Baskall, Jill K Gardner, and Mark W. Allen  
 2007 Advances in Understanding Mojave Desert Prehistory. *California Prehistory: Colonization, Culture, and Complexity*, 229-245.
- Verhagen, J. W. H. P.  
 2013 On the road to nowhere? Least cost paths, accessibility and the predictive modelling perspective. Proceedings of the 38th Annual Conference on Computer Applications and Quantitative Methods in Archaeology, CAA2010.
- Wangler, Michael J., and Richard Minnich A.  
 1996 Fire and Succession in Pinyon-Juniper Woodlands of the San Bernardino Mountains. *Madrono; a West American journal of botany* V.4(1-4): 493-514.
- Warren, Claude. N.  
 2002 Time, Form, and Variability: Lake Mojave and Pinto Periods in Mojave Desert Prehistory. *Essays in California Archaeology: A Memorial to Franklin Fenenga, Contributions of the University of California Archaeological Research Facility*, (60): 129-141.
- Weaver, Richard A.  
 1982 The 1776 Route of Father Francisco Garces into the San Bernardino Valley, California; A Reevaluation of the Evidence and its Implications. *Journal of California and Great Basin Anthropology*. 4(1): 142-147.
- Wells, Phillip V. and Clive D. Jorgensen  
 1964 Pleistocene Wood Rat Middens and Climatic Change in Mohave Desert: A Record of Juniper Woodlands. *Science*, 143(3611): 1171-1173.
- White, Leslie  
 1943 "Energy and the Evolution of Culture". *In Anthropological Theory. An Introductory History*. Mayfield Publishing Company (1996).

White, Tim, and Wes Reeder

- 1970 An archaeological survey of the deep creek drainage, San Bernardino Mountains, California. On file at the San Bernardino National Forest Service Supervisors Office. Site record for CA-SBR-444 (1968).

Whitley, David S. and Ronald I. Dorn

- 1993 New perspectives on the Clovis vs. Pre-Clovis controversy. *American Antiquity*, 58(4): 626-647.

Winterhalder, Bruce and Eric A. Smith

- 1981 New Perspectives on Hunter-Gatherer Socioecology. *Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses*, 1-12.
- 2000 Analyzing Adaptive Strategies: Human Behavioral Ecology at Twenty-Five. *Evolutionary Anthropology: Issues, News, and Reviews*, 9(2): 51-72.

Wood, Brian. M. and Zoe J. Wood

- 2006 Energetically Optimal Travel Across Terrain: Visualizations and a New Metric of Geographic Distance with Anthropological Applications. In *Visualization and Data Analysis 2006* (Vol. 6060, P. 6060, F.). International Society for Optics and Photonics.

<http://www.usclimatedata.com/climate/san-bernardino/california/united-states/usca0978> (accessed 3-10-17)

<http://fs.usda.gov/sanbernardino/vegetation/> (accessed 3-1-17)

<http://fs.fed.us/sanbernardnio/pinyonpines/> (accessed 4-2-17)